

**USING INTERACTIVE SOFTWARE AS A CONCEPTUAL TOOL:
AN EXAMINATION OF COGNITION IN IMPROVISED MUSICAL
PERFORMANCE**

by

TIMOTHY THOMAS SAYER BA(Hons) MSc

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degree of

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Department of Music, Dartington College of Arts

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Abstract

Viewing musical improvisation in the light of psychology and cognitive science, this thesis will explicate the rationale behind the development of a software based audiovisual interface for use in improvised solo instrumental performance. The evolution of the performance environment is presented along with the theories and concepts that have shaped its progress. The opening chapter will review the terms of reference used throughout the work and will set a boundary around the area of examination. Chapter two will place musical improvisation within the context of human behaviour and in so doing will draw upon theoretical discourse from the fields of evolutionary psychology and cognitive science. This chapter will explore the nature of volition and its relationship with subconscious processing, drawing upon anecdotal evidence from improvising musicians as linkage between theory and practice. Chapter 3 augments the study of the inner world of the improvising musician by encompassing the communicative functions of this activity. The boundary of this study does not embrace musical interactions between musicians in a dialogic sense, my remit here is to explore behavioural response to sensory information and the mechanism by which this may or may not manifest itself in conscious thought. Chapter 4 sees the development of a theoretical model with which to contextualise the practice of musical improvisation and to provide the foundation from which to evolve the architecture for an experimental performance environment. This leads in Chapter 5 to a discussion around the function and nature of tools as problem solving devices, looking at conceptual and physical tools and the mapping of functionality. The discourse in this chapter is aimed at providing a rationale for the development of a software based tool to address some of the issues raised previously in the study. The concluding chapter will document the evolution of a software based audio-visual performance environment, mapping its various incarnations and its relationship to the theoretical model developed over the course of the previous chapters. This chapter will refer to documentation and audio visual material on CD Rom and DVD found in Appendix I.

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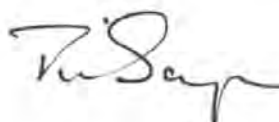
Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award.

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Workshop/Conference Attendances

Deep Listening Workshop	2001	Pauline Oliveros, Dartington College
Hybrids – Sonic Arts Network	2001	Sonic Arts Network, UEA
ICMC02	2002	ICMC, Havana
Sound and Space	2003	Cambridge University
Hypnotherapy Workshop	2003	Sussex University
Practice and Research	2004	Bath Spa
Advanced Hypnotherapy Workshop	2004	Sussex University
IDM04 (interactive dance music)	2004	Middlesex University
LAM (live algorithms in music)	2005	Goldsmiths College

Presentations

Cyberonica02	2002	ICA, London
1st International Conference of Performance Technology	2003	Doncaster
Beyond Noise	2003	UCSB, California
Research Seminar	2005	Dartington College
Cyberonica05	2005	Science Museum, London

Public Performances

Mosaic	2002	Pauline Amos, Strange Noise Concert
Hexagram	2003	Works Ensemble, Dartington College
Lost Hour	2003	Night-Walking Installation, South Bank
FreeKey	2002	Sam Richards, Totnes Jazz Collective
FreeKey	2005	Dave Holland, Totnes Jazz Collective
Moving the Sun and the Traffic	2005	Dave Murphy, Concourse, Dartington

Publications

Software Intervention in the Process of Improvisation - Digital Creativity Vol14 No2 Swetz & Zeitlinger, Holland

Introduction – A Personal Statement

This work has been the culmination of a journey that has taken many years to complete. I first began playing the trumpet at primary school and continued in secondary school, working my way through the grade system. On leaving secondary education, the vast majority of my peers from my inner-city comprehensive school moved seamlessly into apprenticeships at Portsmouth dockyard. Having a strong desire to pursue music as a career, the only option presented to me was to join the services. On my departure from the services I undertook 'A' levels and an interest in improvisation through modern jazz grew, hearing for the first time live performances by Dizzy Gillespie, Miles Davis, Keith Jarrett, John McLaughlin and the like. There is a sense that I was attracted to jazz not purely as a musical phenomenon. The stories, anecdotes and urban myths that have imbued the world of jazz convey a sense of excitement and nonconformity which I found attractive as an adolescent. Ironically as the years have passed, it is the extra musical aspects of this genre that have caused me to question the validity of what I do when I perform jazz. That is not to say I don't gain significant satisfaction and enjoyment from performing this music, but I am acutely aware that this endeavour owes a significant debt to a musical and cultural lineage that is not my own.

I attended Dartington College of Arts during the eighties and was lucky enough to fall under the wing of trombonist and composer, Jim Fulkerson. This encounter had a significant effect on my trumpet playing and musical aspirations. I was introduced to extended brass techniques, new approaches to improvisation and players such as Albert Mangelsdorf and Evan Parker. As a player, I began to feel empathy with the musical movement broadly termed 'free improvisation' and felt comfortable operating within that aesthetic and lineage. On leaving Dartington I undertook an MSc in computer science in Stafford and simultaneously found myself being engaged for commercial trumpet playing work in London. I lived and played in London for a number of years before returning to Devon to take up a lecturing position at the College of St Mark and St John where I currently teach digital media.

The reason I find it hard to pin point where the journey of this study began is because over many years of playing, a whole host of concerns, anxieties, annoyances and intrigues have influenced my desire to gain a greater understanding of improvised music making and to explore the various parameters that exist in this performance paradigm. I will recount three examples of the types of incidents that have fuelled my motivation.

Playing From A Script –During the 1980's I was engaged to play at the WOMAD festival with a free jazz ensemble named 'Out To Breakfast', the members of which I knew only vaguely. When I arrived I was presented with a number of scripts which related to the sections of the performance. The scripts contained either specific instructions, some prose or a combination of the two. Each script was to be read prior to the section commencing and each performer was required to bring to mind the sentiment of the prose contained within the script. I was intrigued by the influence that the prose had on the performance, and was surprised at how such a subtle intervention could have such a profound effect on the behaviour of the musicians. It seemed to me that in many ways, the prose was a more effective tool than the instructions for eliciting a particular response from the musicians.

Playing When Angry – There was once an occasion when I arrived at an engagement only to find I had been double booked with another player. Far from being apologetic, the organisers were very discourteous. I had no means of leaving the venue because I was reliant upon a lift from another musician, and so I had to wait in the dressing room for the duration. With nothing much to distract me, I became angrier and angrier as time went on. Towards the end of the performance, one of the band members came from the stage and asked me if I would be prepared to come and improvise in the last piece, to which I agreed. It was a truly cathartic experience in which my emotional state had a significant effect on my playing. It may seem obvious that an improvising musician's emotional state will influence their playing, but what occurred to me, was the possibility that this emotional state could be malleable and could be harnessed in some way within a performance parameter space.

Playing When Distracted – Some years ago at Christmas time I was performing with a quartet at a seasonal meal for a large corporation. The meal was housed in a marquee positioned adjacent to a stately home. The temperature in the marquee was very cold and many of the guests complained. The management positioned electric heaters around the perimeter of the marquee and linked them together with electrical extension cables and then connected the whole lot to a single power point. When the switch was thrown to turn on the heaters, a fuse was blown and the whole place was plunged into darkness. The quartet continued to play, not through any sense of duty, but purely because our minds had been distracted from the music. I can quite vividly remember wondering if I was in any danger and thinking through the ramifications of an electrical overload such as this. I then became aware that there were many waiters clearing tables, with plates piled high on their arms which were beginning to fall off as they tripped and stumbled around in the darkness. When my mind returned to my playing, it took a moment for me to catch up with what I was doing and where I was going in my improvisation. We finished the piece in darkness and the audience cheered and applauded heartily for the first time in the whole evening. It seemed somewhat ironic that the darkness had brought their conscious attention to the music while simultaneously taking mine away.

In undertaking this study it has occurred to me that it is an audience that makes music, not a musician. It is the choice of an audience member to interpret sound as music or not. I use the word choice not to denote a conscious choice but a human, primal choice, a choice based on an internal decision provided by the cognitive models which a person's sub-conscious uses to process and interpret sound. The condition for this decision is evaluated differently by different people because the resources used to make that evaluation are different for different people. In the case of a piece of composed music, the decisions made in the construction of the piece can be taken in the light of possible/probable interpretations constructed by an audience, as a result of their processing of the sound. An improvising musician is simultaneously both creator and consumer of the sound world which s/he shares with the

audience. This dual role puts the performer in conflict between, on the one hand, the desire to construct meaning by interpreting sound in the light of pre-existing cognitive models of what constitutes music, and on the other hand, augmenting the existing model to include within the interpretation, musical material which doesn't exist within that model. As an improvising musician this seems to be at the heart of my dilemma, fuelling my motivation to construct new improvised music performance environments. .

Chapter 1 - Terms Of Reference

This study is an examination of cognition in improvised musical performance and explores the potential of interactive software to provide conceptual tools to address some of the issues which arise from this examination. Part of this endeavour is to provide a practical and theoretical framework for the creation of improvised musical performance in which psychological techniques and technological intervention are used as tools to augment and challenge established notions of a performance paradigm. To that end the study will comprise explorations into a variety of theoretical arenas to underpin the conceptual basis for the model of the performance paradigm and the development of computer based performance systems. Project documentation for the evolution of the system and documentation of its use are also included.

This chapter will define terms and techniques which will be utilised within this study. It will define a boundary around the area of study and justify the elements that have been included and excluded. It would be impossible to elucidate all the influences that have come to bear on the development of this work: the volume would be too great, many would have little relevance and perhaps most importantly many have not revealed themselves and perhaps never will. Many pragmatic issues, however, can be dealt with. Issues of process, methodology, language and interpretation can be discussed in terms of their usage and the manner of their expression.

1.1 Systems Theory

Throughout the research I have undertaken to complete this study, systems theory has reoccurred as a theme numerous times in differing contexts. Although I have been aware of systems analysis methodologies within the field of computer science I became aware of the parallel development of systems theory within a range of other disciplines, disciplines that have come to bear significant influence on my examination of the improvised music

performance paradigm. The definition of systems theory offered by Heylighen and Joslyn is sympathetic to my own understanding of this term.

Systems Theory: the transdisciplinary study of the abstract organization of phenomena, independent of their substance, type, or spatial or temporal scale of existence. (Heylighen and Joslyn 1992)

I have constructed an initial premise from this philosophical perspective. The premise being that there is not a system in the material world that exists in isolation from all other systems be it physical, biological or conceptual, with musical improvisation being no exception. Not only is this activity non-autonomous but it continues to defy a consensual definition amongst those who engage in it and those who study it. Like so many culturally defined super-ordinate terms 'improvisation' is used in reference to a range of human activities and even when applied to those that are classified as 'musical' it fails to provide a consistent term of reference. Viewing musical improvisation as a communication system comprising many subsystems will I hope clarify the areas of the process under examination in this study.

Like natural language, music is a system that consists of a hierarchy of systems. Each system has its fundamental components: the 1/50,000th-of-a-second micro-sound sample, the note or sound event, themes and phrases, and ultimately the structure of a complete work. Each system has its rules for describing its structures: for combining and sequencing elements. And each system can itself be seen as the base element of another system at a different level in the hierarchy. (Holtzman 1994) [156]

From here on, I will use the term 'improvisation' to refer to musical improvisation. Within this human activity the domain in which I have particular interest comprises systems that support the preconception, conception and formalization of ideas. Although there is not a large body of work providing an examination of this domain, specifically in relation to the spontaneous creation of musical material, there does exist a wealth of material within the fields of evolutionary studies, cognitive and behavioral science and linguistics with which to construct a plausible model of improvisational behaviour in the field of music.

Improvisation exists in a variety of physical locations and social contexts. It can be engaged in by differing numbers of participants and be subject to a variety of organisational and relational forms. This study is primarily concerned with exploring improvisation from a

performer-centric perspective not in terms of audience perception or to any great extent evaluating the musical output of the performance. This is an examination of improvised music making as human behaviour, investigating the experiences which relate to an individual engaged in that activity. No discrete evaluation of group dynamics, player/audience relationships or socio-political theory will be undertaken. To that end, performance environments developed as part of this study have involved solo performers interacting with technological systems.

1.2 Spoken Language

In certain contexts there exists a broad similarity between musical improvisation and spoken language, with the seemingly seamless formulation, encoding and transmission of sonic material. During this study reference is specifically made to spoken language, as opposed to written language and mark making, because of the area of commonality that many practitioners perceive it to have with improvised music. Some of the observations applied to language in this section may therefore not apply universally to all aspects of language but only to spoken language as it occurs spontaneously and naturally. This does not therefore include narration, recitation or any form of vocal commentary which is delivered via the use of a pre-written script. The aspect of language explored in relation to this study focuses on the mechanics and physicality of the spontaneous formulation, encoding and delivery of linguistic information via vocal transmission. That is to say, the analysis of linguistic content in terms of cultural and critical theory and semiotics will not play a significant role in this study.

1.3 Cognitive Science and Neuroscience

It is perhaps inevitable that the analysis of an aspect of human endeavour in terms of its behavioural characteristics will encroach on the area of psychology and neuroscience. I attempt to treat these themes discretely, dealing mainly with the implications for improvisation arising from the field of psychology and cognitive science. There seems to be a legitimacy in divorcing these two fields, a view held by Fodor who clearly believes that cognitive science and neurophysiology can and should be studied independently.

This criticism is bolstered by Fodor's endorsement of the strict separation of psychology from neuroscience. According to Fodor, the neurological properties of the brain are irrelevant to its cognitive properties. (Zawidzki)

Within this particular area of examination it is necessary to highlight any potential mismatch in terminology. One such misinterpretation could occur when dealing with the concept of perception. When making reference to perceptual processes, in the light of Sperber's work, I should make clear that I am not alluding to conscious perception but to the low level processes responsible for receiving sensory data prior to that data being conceptualised and passed to consciousness for human perception. The distinction between perception as receptivity rather than consciousness is one made strongly by Debono in his examination of perception in plants and evolution of human consciousness. (Debono 2004)

It is particularly necessary to distinguish between the various uses of the word perception, in chapter 4, when dealing with the notion of mapping. When examining a conceptually high level activity such as a musical performance a satisfactory definition of this term could be to make manifest a conscious response to sensory data based on the recognition and interpretation of that data. When examining human activity at a lower conceptual level, such as the inner workings of cognition, it is necessary to refine this definition to exclude consciousness from the process. The distinction between the term 'perception' in relation to low level perceptual processes and its general usage which tends to refer to 'conscious-perception' is very important to establish, however is it essential that the latter is understood to be perception that is revealed to consciousness and not constructed by or controlled by consciousness. Throughout this study consciousness is regarded as the passive receptor of information, the passenger rather than the driver and so 'conscious-perception' refers to perception of which one is conscious as opposed to the lower level perceptual modules of which one is not conscious. In justifying this position I will develop the notions of 'bio-mechanical' and 'cognate-mechanical' behaviour as a means of distinguishing these two types of perception.

1.4 Metaphor of Mind

Throughout the ages, metaphors to describe brain processes have been borrowed from the technology of the day. This phenomenon has been traced by authors such as Frank Tallis (Tallis 2002). Phraseology such as 'letting off steam' and 'being under pressure' originated in the hydraulic era of the 19th century. This was followed by the introduction of electricity in the 20th century and with it notions of being a 'bright spark', 'run down' or 'blowing a fuse'. Some believe that the relationship between psychological metaphor and the technology of the day will expire as knowledge about the mind becomes based more on hard science than conjecture, and as the field develops its own vernacular.

Thankfully, the study of the human brain itself has advanced tremendously over the past decade. We now have a direct understanding of how the brain itself works which is unparalleled in history. It is to be hoped that metaphorical reference to current technologies may no longer be necessary in future years. (Tyrrell 2003)

Although this may become apparent in the future, at the moment the metaphorical language of computer technology has a significant influence on the language used to describe matters of the mind. Crude parallels between working, short and long term memory in humans are regularly drawn with memory in computers. Cognitive processes in humans are perhaps equated to data processing in computers, with operating systems that utilise interrupt levels mapping onto the notion of cognitive goal states.

From time to time during the course of this study I have adopted this metaphorical approach in order to abstract a particular meaning. I have done so for two main reasons. Firstly, it serves my purpose to draw analogies with computer technology since there is a relationship between my interpretation of human cognition and the development of a software based performance tool. The second reason is that it is a common analogy used in the literature and hence it is used in work I have referenced, to elucidate concepts that are apposite to my theme. I am mindful of the fact that the mind - computer analogy is an anathema to many academics but I would suggest that in the context of this work its use as metaphor is quite benign. It is not my intention to present the technological component of this thesis as having

a mimetic relationship with human cognitive processing but to embrace the notion of the computer as offering a form of prosthetic mental functioning or as Fredrick Brooks would have it 'Intelligence Amplification'. (Reingold 1991) David Cope draws on the vision of Jacob Bronowsky in his examination of the relationship between composer and computer and it is this sentiment that I have tried to embody in the relationship this study sets up between improvising performer and computer. His notion of the continuous relationship between humans and machines resonates strongly with the ideas surrounding tools and prosthetics discussed in chapter 4.

we are now coming to realize that humans and the machines they create are continuous and that the same conceptual schemes that help explain the workings of the brain also explain the workings of a "thinking machine." Human pride and its attendant refusal or hesitation to acknowledge this continuity form a substratum upon which much of the distrust of technology and an industrialized society has been reared. Ultimately this distrust rests on the refusal by humans to understand and accept their nature - as beings continuous with the tools and machines they construct. (Bronowsky 1993) [4]

1.5 Anecdotal Evidence

In collecting evidence for this study I have deliberately limited the field of enquiry to material which explicates the behaviour of an improvising musician and explores possibilities for technological intervention. A main tenet of this investigation is therefore the performer experience and as such anecdotal evidence has been an important source of information. I do not regard an anecdote, in any sense, to represent a truism, but it can be used as an indication of perception. That is to say, its accuracy may be called into question but, unless the subject is deliberately lying, it can be regarded as a reasonable reflection of what was perceived. In that sense anecdotes are valuable but it needs to be appreciated that they are expressions of closest fit mappings that may or may not accurately correlate the performer's internal and external worlds. Anecdotes, personal as they are, cannot escape the crudity of language as a tool to represent a domain, such as music, that could be considered in some sense meta-lingual.

Anecdotes are also interesting because they can often reveal a mismatch between perceived reality and the actual reality. They present an opportunity for an observer to reconcile the improviser's duality in their performance, that of producer and consumer. For the musician it is a chance to offer justification in situations for which it may not be possible to offer an objective, logically causal explanation; things that just happen. They are useful devices for performers in attempting to rationalise the irrational.

1.6 The Scope of the Prototype

It is important to acknowledge the substantial amount of research that is currently being undertaken in the field of computer music interface design. A reasonable overview is presented by Di Scipio and others. (Di Scipio 2003) It must be understood that the remit of this project does not extend to the advancement of fields such as generative and algorithmic music, pitch or beat tracking, autonomous agent technology, artificial life, advanced DSP or any other topical area of computer music systems development. Sound processing and production algorithms developed for this study exist only to provide a range of mappings onto the performance parameter space. This mapping attempts to interface with an improvising performer's cognitive and psychological state. The visual and sonic output from the computer is responsive to the performer's musical output by using a range of stochastic processes governing the behaviour of the various software components. A working prototype has been developed for this study to explore these ideas which interfaces routines for producing a visual response to the performer and routines for producing a sonic response. Because of the component based architecture that has been adopted for the development of this prototype the audio visual routines that have been submitted could be substituted for patches produced by other developers. Although during the period of research a number of stand-alone performance systems have been produced it was always the intention to ultimately produce a flexible tool rather than a fixed artifact and as such the majority of the development effort has been applied to the framework rather than the patches with which it interfaces.

1.7 Tools and Toolmakers

As with traditional tools, computer based tools can be viewed as existing sometimes discreetly and sometimes layered between, and interfacing with, other tools. Just as a work bench can interface with a vice or a pillar drill and the drill can interface with a range of bits, so it is with software. The main difference between the traditional and the digital is that for software tools it is generally only the layer that interfaces with the user that is visible. The layers on which the top layer depends are buried like Russian dolls beneath a stack of software components that are ultimately supported by the machine's native language. The sub-layers provide the necessary servicing up and down the hierarchy in order that the human computer interface can provide its promised functionality but without revealing themselves to the user. It is interesting how the traditional view of the tool clearly attributes notions of invention and creativity entirely with the tool's user with minimal credit given to the tool's creator. In the world of software the situation is rarely clear cut. It is not uncommon for someone working in a computer based environment to be simultaneously utilising half a dozen or more software components simultaneously, from the graphical user interface, the database engine, the audio plug-ins, the display drivers, the operating system and the bios.

The ISO interconnecting network model is a prime example. This model is a seven layer standard defined by the International Standards Committee which defines, for each layer, services to the network layer above and below while maintaining a protocol compatibility with the equivalent layer on the system with which it is communicating. It is important to be aware of the notion of a system or tool being comprised of layered components in order to appreciate at what conceptual level the creation of a new piece of software has been undertaken. The lower level or more 'native' the software is to the machine on which it is being executed, the less reliant it is on building blocks provided from other sources. There is of course a trade off between working at the highest and lowest level. The amount of time and effort needed to complete a task rises exponentially the lower the level of the development environment, where as the higher the level of the development the less

expressive the environment becomes. Imagine writing a book using only language suitable for five years olds at one extreme and creating a new language from scratch with which to write a book at the other extreme: complete freedom to create the book and the language in which it is written, on the one hand and being restricted to a sub set of the language on the other. The production of software tools can be positioned in one of two broad camps. It may be helpful to position software produced for this project in relation to the development process and its eventual usage. Broadly speaking a software tool can be used by a software developer to create other pieces of software, a software 'hammer and saw' if you like, or it can be a tool for an end user, a software 'chair and table'.

In the creation of the various interfaces to explore the ideas and concepts in this project it was necessary to first construct the former in order to create the latter. I will refer to the former as the prototype development tool and the latter as the application or performance system. The prototype development tool in its present form has been constructed using a high level development environment and comprises a versatile software component that is parameterised and configurable. It is designed for use within the development environment by novice programmers to construct performance systems.

1.8 The Conceptual Tool

The term 'conceptual tool' requires clarification in the context of this study. In some sense it is true that I have produced an artifact which can be used to make performances, and in that sense it could be regarded as a physical tool. From my perspective I view the artifact I have created as being a realisation of a conceptual tool and that the idea of making an instance of the conceptual tool need not be confined to a software application.

In essence the conceptual tool I have created comprises two maps, one interfacing the performer's sensory perception to their behaviour and the other interfacing their behaviour to a responsive environment. The first map is realised using a hypnotic script, delivered prior to the performer consciously engaging in the performance. This script is designed to circumvent

the performer's normal response mechanisms in a performance situation. What I am describing when I use the term 'normal' are musical responses that the performer recognises as being automatic or mechanical. It is important to reiterate that this does not take an audience's perspective into account. There is always someone in the audience for which the whole performance is likely to be new. The mapping procedure for the first map, expounded in chapter 4, is executed in three stages, the third stage being the performance. The mapping procedure for the second map is undertaken largely by the performance designer, which may or may not be the same person as the performer. The function of the performance designer is to make decisions about the nature of the performance, such as duration, number of sections etc. and to configure the sonic input to the audio/visual response. This mapping can be completed entirely prior to the performance or can be manipulated in real time during the performance. Obviously if one person is both performer and performance designer, real time manipulation during performance would be problematic. In the construction of the first map, the hypnotic techniques I have employed owe much to the Milton Erickson school of hypnosis which make significant use of metaphor in its hypnotherapeutic interventions. In this regard I have not adopted what might be regarded as 'hard-core' post hypnotic suggestion in the scripts I have developed. My reasoning in this has been guided by my belief that the function of my research is to emancipate a performer's musical behaviour from the constraints of their conscious mind rather than to impose upon them constraints which I have constructed.

Chapter 2 - Improvisation and Human Behaviour

2.1 Evolution of the Brain - Spontaneity Versus Learnt Behaviour

In recent years the development of evolutionary psychology has pointed the way to a new interpretation of human behaviour. The suggestion being that, along with physical adaptations that have taken place over the course of history, human beings' behaviour has experienced a similar evolution. It is clear that the majority of human cognitive processing is undertaken subconsciously and that those processes that seem straightforward and innate to us are in fact far too complex for most people to understand on a conscious level. Playing chess is a relatively simple process compared to the mechanics of actually seeing the chess pieces, yet we perceive playing chess as quite challenging but 'seeing' very easy. We learn to play chess but we 'see' instinctively, this relationship between the 'innate' and the 'learned' is interesting when examined in relation to musical improvisation. Cosmides and Tooby suggest that the modern human skull houses a stone age mind in which the 'innate' and the 'learned' are not opposites, with the desire and ability to learn being itself instinctive. (Cosmides and Tooby 1997) Even if this were the case, it still does not deny the possibility of an evolving relationship between the two. In fact, there seems to be a strong case to suggest that the evolution of this relationship is supported by humans' biological evolution. As Gurney suggests, the development of the thalamus and neocortex has led to greater control over behaviour thus reducing automatic or reflex type responses in favour of learned responses.

... reasoning points to the separation of the new planning and reasoning areas of the brain from the older 'emotional' centres. It is conjecture that herein lies the reason for man's 'objectivity'. He is less subject to the immediate demands of his emotions. The separation of the reasoning and emotional centres would have provided the opportunity for man to cope rationally with most situations, since it is known that strong emotions tend to disrupt organized behaviour, including learning. (Gurney 1973) [42]

The consequences of a cognitive pull such as this could have significant ramifications within the field of musical improvisation. Many of the frustrations expressed by improvising

musicians centre around the continuous battle to generate original material; to evolve the music beyond that which has been played before. In this endeavour it may seem that the improvising musician is swimming against the evolutionary tide.

one of the themes of man's emergence was the loosening of instinctive reflex actions in favour of the learned control of voluntary behaviour. (Gurney 1973) [40]

Gavin Bryars, once working as a bass player in the field of improvisation, moved away from this practice to create music through composition. The demise of his belief in improvisation as a valid art form came as a result of experiencing performances which in some sense seemed to be fraudulent. Although he identifies instances where he believes performers are knowingly deceiving in their performance, his issue with improvisation seems also to exist on a general level. In his discourse with Derek Bailey he extends his objection beyond that of deliberate deception in his assessment of the relationship between improvising musicians and the music they create.

One of the main reasons I am against improvisation now is that in any improvising position the person creating the music is identified with the music. The two things are seen to be synonymous. (Bailey 1992) [115]

Bryars seems to be intimating that it is impossible for an improvising musician to remain objective during a performance, and that this psychological state compromises the autonomy of the art work. It is not only within the field of improvisation that this psychological state has been identified. The Russian philosopher Peter Ouspensky in his paper 'The psychology of man's possible evolution' identified four general states of consciousness; 1 - sleep, 2 - waking sleep or relative consciousness, 3 - self-consciousness and 4 - objective consciousness. Ouspensky places these states on a continuum from subjective to objective with state number one, sleep, being purely subjective. Ouspensky suggests that people tend to spend the vast majority of their waking life in state number 2, in which their subjectivity is extended to include the perception of 'I' and 'not I'. Within this state he defines a number of characteristics and traits that people exhibit, one of which lends weight to Bryars' observations.

'Identifying' or 'identification' is a curious state in which man passes more than half of his life. He 'identifies' with everything: with what he says, what he feels, what he believes, what he does not believe, what he wishes, what he does not wish, what attracts him and what repels him. Everything absorbs him, and he cannot separate himself from the idea, the feeling, of the object that absorbed him. This means that in the state of identification man is incapable of looking impartially on the object of his identification. It is difficult to find the smallest thing with which man is unable to "identify'. At the same time, in a state of identification, man has even less control over his mechanical reactions than at any other time. (Ouspensky 1940) [42]

If this state is so ubiquitous, then the premise that, when two or more sentient beings communicate they are performing a conscious objective act, must perhaps re-evaluated. This argument has been employed by Karl Rosengren and others to distinguish the way human beings communicate from other animals and plants.

when human beings communicate, we know that we do so. Each one of two communicating participants is aware of the (sometimes potential) presence of the other, and of the fact that communication is occurring (or may occur). (Rosengren 2000) [6]

An additional flaw in this premise, that supports Ouspensky's theory, is that much of our communication exists on channels that are not generally subject to intellectual filtering, body language and vocal intonation being two obvious examples. This situation exists in an improvised music setting as much as anywhere else. Facial expression, speed of movement, body gesture, physical positioning etc. are all able to communicate information in which the performer's perceived intent plays no part. Cook's analysis of multimedia communication suggests that gesture and body movements of musicians, whether conscious or not, form part of the communication medium. He cites the performances of Jimi Hendrix as an example where the interaction of sound and body movements becomes a source of meaning. (Cook 1998) [263]

Rosengren's typology extends the model of communication to include what he terms unintentional and subconscious transmission.

		Individual is conscious of action/behaviour	
		Yes	No
Action/behaviour is intentional	Yes	1 communication as action	2 communication as subconscious action
	No	3 bodily behaviour such as blushing, stuttering, sweating, trembling	4 unconscious bodily behaviour such as small facial changes

(Rosengren 1984) [7]

Figure 2.1 A communicative-orientated typology of action and behaviour

While the inclusion of these aspects offers us insight, by way of exemplars of the types of behaviour that are generally regarded as involuntary, the overall model, which suggests the conscious and subconscious to be a binary state, remains problematic. Ouspensky's notion of consciousness as a continuum on which a human activity can be placed in accordance with a persons' overall psychological state seems more plausible.

In connection with this I must say at once that I do not mean what is called in modern psychology 'the subconscious' or 'the subconscious mind'. These are simply wrong expressions, wrong terms, which mean nothing and do not refer to any real facts. There is nothing permanently subconscious in us because there is nothing permanently conscious; and there is no 'subconscious mind' for the very simple reason that there is no 'conscious mind'. (Ouspensky 1940) [29]

The suggestion by Ouspensky seems to be that cerebral activity is in constant flux, never achieving an absolute state and that the conscious and subconscious domains are influential in all psychological phenomena.

2.2 Models of Memory

In his examination of improvisation and cognition Pressing makes a distinction between long and short term memory in a musical context in which he suggests that long term memory tends to hold information relating to the stylistic context in which the performance exists.

This could include the musical tradition, standard repertoire and instrumental technique. Pressing's notion of short term memory is rather akin to the more popular term 'working memory' which relates to temporary storage during engagement in a mental process. He sees short term memory as retaining information localised to the current delivery moment in a performance. This suggests that the performer circumvents Miller's limitation of the conscious mind by chunking together pieces of primary data into higher conceptual constructs (Miller 1956). Just as a reader assimilates words rather than letters, a jazz musician utilises chord sequences rather than individual notes. While these two memory modes are useful reference points in examining the information processing that takes place during a musical performance, it provides only a continuum on which to place an information retrieval activity. This is because there is no definable boundary between short and long term memory. If the moment-by-moment choices that a musician is making are beholden to a higher conceptual order utilised by the chunking activity, then this conceptual order must reside in long term memory. Chunking is not a discreet activity; it relies on the primary source of data and the conceptual system from which the chunks are created.

The traditional distinction into short- and long-term stores is adequate for many purposes. Long-term memory critically shapes the kind of sound ideas the performer will produce, and the way in which they will be developed. This memory ranges over musical theory and composition concepts, 'auditory images', specific pieces and motives, and memorized muscular sequences (action units), corresponding roughly to the traditional music labels of theory, musicianship, repertoire and technique. Each of these areas allows the cognitive organization of many events under smaller umbrella concepts like scale, modulation, interval of a major sixth, mordant, 'swing' time, etc. (Pressing 1984) [360]

Pressing has presented the extremes of the long term, short term continuum without convincingly addressing the murky area where they touch. In some ways even the notion of a continuum is too clean a concept and there is perhaps room for an interpretation of long and short term memory in which the two modes overlap. The human brain is so efficient at processing and interpreting data that it is sometimes hard to distinguish between that which is currently being processed and that which is offered from memory as an interpretation. Take the following example:

According to research at an English university, it doesn't matter in what order the letters in a word are, the only important thing is that first and last letter is at the right place. The rest can be a total mess and you can still read it without a problem. This is because we do not read every letter by itself but the word as a whole.

This is an example of what might be termed meta-chunking. If we look at the words in isolation then this cognitive trick doesn't work. If the chunking process fails to offer an acceptable interpretation (i.e. one that creates a match in long term memory) then the chunking process moves to the next level of abstraction. Instead of looking at the letter in context it looks at the word in context. This is undoubtedly an extremely helpful facility, a pre-processor that parses incoming data and presents it in an acceptable form for semantic interpretation. This is helpful indeed, unless it is unwanted, in which case there is a huge cognitive overhead required to suppress the facility. Reading the previous paragraph as is, without making the automatic corrections, is hard work.

The discussion on memory so far has focused largely around information retrieval. There are however, issues surrounding the encoding and storage of information in memory which are relevant to the improvising musician. In defending an umbrella notion of memory rather than a number of discrete types of memory, Copelman suggests that although we can use a number of different concepts to understand the way information is encoded, stored and retrieved, they rarely, if ever, operate in isolation. (Copelman 2003) Long term memory contains short term memories that have been filtered in accordance with personal goal states. These goal states, according to Conway, are largely responsible for decisions about what is filtered in, what is filtered out and what type of structure the information is held in. (Conway 2003) It is interesting that by drawing from the world of computing, metaphors such as data types, data structures and symbol tables, we are able to conceptualise this process in a similar vein to Miller in 1956.

Our memories are limited by the number of units or symbols we must master, and not by the amount of information that these symbols represent. Thus it is helpful to organise material intelligently before we try to memorize it. (Miller 1956)

Although Miller's observation is undoubtedly correct, there is no way, as yet, to concur that the external organisation of information that is committed to memory has a correlation to its internal representation. Similarly, the logical representation of data on a computer screen, as perceived by an operator, is likely to be organised very differently to the internal data model. In terms of locating and retrieving information, human logic is not necessarily efficient.

Copelman also suggests that, contrary to what we might like to believe, we have very little conscious control over the management of our memory. He suggests that even though we might make a conscious effort to remember things, whether they stick or not is beyond conscious control. The vast majority of information we retrieve from memory has been encoded and stored without our being aware.

Another way of conceptualising memory, orthogonal to the long/short term model, is with a semantic/episodic framework. This concept relates to the nature of the information being encoded and stored rather than the time frame, with the term semantic memory representing facts and concepts and with episodic or autobiographical memory representing events. For a performer the chord sequence for a particular jazz standard would use semantic memory, while a particular performance would use episodic memory. The performer may remember exactly the chord sequence but is unlikely to be able to recall the event of it being learnt. On the other hand remembering a performance is likely to bring back lots of contextual information but without the precision of every aspect of the event. In this instance it seems reasonable to concur with Copelman that the operation of these modes is interrelated in some way. For example, if a particular performance introduced a new chord substitution it is possible that over a period of time that substitution would become assimilated and eventually become the norm, thus moving from episodic memory to semantic memory.

2.3 Motor Control and Skill Acquisition

It is particularly important to distinguish between the higher order semantic/episodic and long/short modes of memory operation and that associated with motor skill acquisition and

performance. It is not necessary to explore the technicalities of how these systems operate but suffice to say that there is reasonable evidence to suggest that motor skill acquisition and performance operate in a completely different location in the brain and have a discrete physical operation to that of higher order memory. Copelman recalls a patient who, after suffering brain damage, experienced severe amnesia. He couldn't remember the fact that he had learnt the piano or that he was an accomplished performer but amazingly he could still play very well. Motor skill execution is of particular importance to instrumental performers but there is a consistency across all physical motor skills in the manner of acquisition. The process seems to begin with the repetition of small units of activity, which may be undertaken and evaluated using multiple senses. In terms of a musical instrumentalist this obviously utilises audible feedback but probably uses a visual mode of feedback too, such as observing finger movement on a fret board. The process continues by constructing larger units from the primitive units of activity and so placing them in a range of contexts. At this stage the parameters and variants in the activities and their triggers can be developed. The repetitive act is in effect embedding a neural program into semantic memory which can then be triggered and passed a range of parameters. The effect of this is to significantly lighten the cognitive load, as once the activity has been triggered the detail in the activity can be undertaken with minimal conscious control, responding only to changes in its parameter space. A pianist could practice a scale in this way and when the motor units had been fully committed to memory the activity could be executed without conscious control over each of the component parts. The motor program may have a speed parameter that the pianist can control but is perhaps unlikely to have a parameter to change the intervals between the notes. In this way a whole catalogue of functional units can be triggered and left to run, leaving enough cognitive capacity to be able to undertake other tasks.

There is of course a distinction that needs to be made between the acquisition and retrieval of the activity units and the mode and manner in which they are assembled into larger conceptual units. Pressing makes this distinction by describing 'object memory' and 'process

memory' as the place where the two exist. Crudely speaking 'object memory' for an instrumental musician would hold the activity units associated with playing the instrument, often identified by the blanket term 'technique'. The information required to make use of the instrumental technique resides in 'process memory'. This is where the techniques for what Pressing describes as 'compositional problem-solving' are held. Methods of sequencing and systems for manipulating the parameter space of an activity unit are stored in 'process memory' and retrieved in accordance with the particular mode of performance. It is perhaps worth returning to the notion of cognitive capacity in the light of the processing that 'process memory' feeds. Motor activities such as tying up a shoelace or having a shave are reasonably cheap on processing power, because the pathway through the activity units is comparatively static and can be easily predicted. However, the processing overhead will increase with human activities that require a higher level of monitoring and real-time manipulation. In the former case it's possible for a person to experience a sensation of 'switching off', rather like a screen saver appearing on a computer screen. However, in the case of creative activities, routines executed from 'process memory' holds are likely to be more dynamic, requiring monitoring and parameter adjustment thus making greater cognitive demands. In this case the brain has a complex resource management problem to address in order for the activity to be undertaken effectively. Activities such as game playing and musical improvisation fall into this category but, as with all activities they exist on a continuum somewhere between the extremes of static and dynamic. Their position on the continuum on a moment-by-moment basis is determined by the resource management of the brain but over a period of time can be influenced by the level of pre-programming, or practice that is undertaken. The instinct to efficiently resource cognitive activity can be a double-edged sword when engaging in a creative process such as improvisation. After years of encoding object and process memory it becomes possible for the whole 'creative' process to be undertaken by traversing chains of previously stored information. Pressing summarises opinion on this matter.

Fitts (1965) labelled this the 'autonomic phase', while Schmidt (1968) referred to it as 'automatization'. The result for the performer is a sensation of automaticity, an

uncanny feeling of being a spectator to one's own actions, since increasing amounts of cognitive processing and muscular subroutines are no longer consciously monitored (Welford, 1976) (Pressing 1984)

The systems that govern the use of 'process memory' will be dealt with in significant detail at a later stage but it is important to establish here one essential facility that has a significant influence on its use, namely the notion of feedback. This term requires discrete examination because of the various interpretations that it has attracted in relation to its use in cognitive science. In particular, for the purpose of this study, it is worth exploring the role of feedback as an open or closed loop system.

In this context, a close loop system describes the self-referential nature of activity units drawn from 'object memory' and subsequent evaluation for the purpose of error correction. Pressing describes one such feedback model, known as 'closed-loop negative feedback' (CLNF) (Bernstien 1967), in which an evaluation of intended and actual output is fed back to an earlier stage in the control chain. It is perhaps this process of evaluation that problematises the existence of closed and open loop feedback systems in improvisation. The submission by Pressing (Pressing 1988) that a consensus exists which suggests that both systems coexist seems reasonable if one acknowledges that material drawn from process memory is also subjected to an evaluatory process, the result of which bears influence on the subsequent use of activity units. In this scenario, evaluation is undertaken at two levels simultaneously, but the nature of the evaluation is necessarily very different. It seems appropriate to apply the principles of closed loop theory to the evaluation of the primitive motor units, which suggest that a 'perceptual trace' of an activity unit is built up from its previous executions to form a template against which to gauge the success of its current execution. This theory (Adams 1976), has particular appeal for motor actions undertaken by improvising musicians because of the autonomous manner of their execution but is not sufficiently flexible to cope with this situation at the 'process memory' level. Pressing recognises why this should be the case when he asserts that in an improvising musician "the ability to construct new, meaningful pathways in an abstract cognitive space must be cultivated. Each such improvised pathway between

action units will sometimes follow existing hierarchical connections, and at other times break off in search of new connections" (Pressing 1984). He pursues this idea in his later work (Pressing 1988), by exploring various template matching theories, augmented to render them suitable for an open loop feedback system (e.g. motor schemata (Schmidt 1983), action plan (Miller, Galanter et al. 1960)). The attempt in these theories to increase the level of flexibility in the evaluation process is driven by the need to model the *novelty* or *invention* of improvised music. The addition of flexibility does not however resolve the dilemma posed by employing a template based model in the evaluation of a process which is in many instances striving to be template free. Where as it seems wholly reasonable to model the activity at micro level in these terms, it seems more plausible that any template based evaluation process is better suited to activities where the probability of template adjustment would be minimal. Another problematic area for both closed and open loop feedback is the fact that a mismatch between expected and actual output, which is regarded as constituting an error, is in some instances regarded, retrospectively, as desirable. In his book "*Effortless Mastery*", Kenny Werner takes an extreme view on this, entitling one of the chapters "There Are No Wrong Notes".

It was said of Monk that he could make a concert grand sound like an out-of-tune upright. There were certainly better pianists around in his day. So why was Thelonious Monk so revered? The answer is that he had the depth of sound, the arrogance to play what he wanted to play. He was uninhibited by mind and fortified by spirit. Behind every note was the belief that "this is the truth." He didn't believe in wrong notes. He believed that they were right notes because he played them. (Werner 1996) [89]

It is hard to think of another activity with such a high reliance on motor skill activity that promotes such a positive attitude to the production of errors. Anecdotal evidence seems to support the notion that far from detracting from the activity, the errors are often regarded as enhancements.

One renowned pianist remembered the relief he felt during a performance when he missed the specific keys he intended to hit and Charlie Parker exclaimed, 'hear you,' having interpreted the erroneous pitches within the pieces' framework as an interesting chord voicing. (Berliner 1994) [33]

2.4 The Limitations of Consciousness

Improvisation like all other human activities has to exist within the confines of available human resources. The previous section has referred to some of the demands made on an improviser's cognitive resource, in terms of various types of memory encoding, storage and retrieval. It is perhaps important to emphasize, at this stage, that information that is being processed consciously at any one time is only a small subset of the overall cognitive workload that is being carried out. It should be remembered that consciousness is a system that is fed information on which it acts and that it sits beside and competes with a multitude of other cognitive systems for resources. That is not to say that if all other competing systems relented, consciousness's performance could be enhanced ad infinitum. Consciousness is subject to the boundary of its own limitations. Miller, in 1965, coined perhaps the best known phrase for expressing a limitation on consciousness, the magic number 7 ± 2 " (Miller 1956). This 'magic number' represented the amount of information threads or 'chunks' that could be retained in working memory at any one time. Another limitation which profoundly affects the performance of consciousness relates to its speed of execution.

There is a long tradition of trying to quantify the performance of human consciousness in terms of speed of performance. In the nineteenth century one of the pioneers of experimental psychology, the German Wilhelm Wundt, developed a range of mechanical devices to measure reaction times. Probably the most well known was a device that became known as 'Wundt's complexity clock'. The principle of this device was to rotate a spot in front of the subject and to measure the time elapsed between the subject being stimulated and the subject reacting. The rotation was at high speed allowing for greater accuracy in the results recorded. By the early part of the twentieth century an Austrian named Hans Berger had started to use electrodes placed on the outside of the skull to record brain activity. The technique was too imprecise to record anything other than very general brain states but by 1965 German neurophysiologists Kornhuber and Deecke used large amounts of repetition to compound the results from the technique and provide reliable data on brain activity around reaction timings.

In doing so they discovered a phenomenon they called 'readiness potential' which suggested that the brain became active anything up to 1.5 seconds before an act was undertaken, in preparation (readiness) for the act to be performed.

In the 1970s Benjamin Libet, professor of neurophysiology at the University of California Medical Center in San Francisco, took this research a stage further. Libet raised the question: if this time lag exists between preparation and the act when are we conscious of the act? It seemed obvious to him that there wasn't a 'one second gap' between deciding to do something and actually doing it. In 1979 he set up an experiment using Wilhelm Wundt's complexity clock to measure the time between the onset of brain activity, conscious initiation of an act and the actual act. The clock consisted of a television screen with a spot revolving at a speed of 2.56 seconds per revolution. The observer could then report where the spot was when they initiated an act. Libet discovered that readiness potential started 0.55 seconds before the act, while the subject became conscious 0.02 seconds before the act. Libet concluded that "cerebral initiation even of a spontaneous voluntary act of the kind studied here can and usually does begin unconsciously" (Libet 1985). From Libet's findings it became evident that the brain can process a response to an externally initiated act more efficiently than one that is internally initiated. Our reactions are therefore quicker than our actions. As Norretranders observes, a burnt finger will be removed from a hot surface before we think "Ouch!". (Norretranders 1998) [221]. This discovery has fuelled the debate on determinism, free-will and volition which has fundamental implications for our understanding of human activities predicated on the notion of spontaneous creation, such as improvisation.

Authors such as George Simmel have, since the early part of the century, been alluding to a psychology of consciousness whose function is to maintain an illusion of control and of the logical execution of volitional acts.

Our actual psychological processes are governed by logic in a much slighter degree than their expressions make us believe. If we look closely at our conceptions as they pass our consciousness in a continuous temporal sequence, we find that there is a very great distance between any regulation by rational norms and the characteristics of

these conceptions: namely, their flaring up, their zigzag motions, the chaotic whirling of images and ideas which objectively are entirely unrelated to one another, and their logically unjustifiable, only so-to-speak probative, connections. But we are only rarely conscious of this, because the accents of our interests lie merely on the "usable" portion of our imaginative life. Usually we quickly pass over, or "overhear," its leaps, its non-rationality, its chaos, in spite of their psychological factualness, in favour of what is logical or otherwise useful, at least to some extent. (Simmel 1917) [311]

If volition is pre-empted by subconscious cerebral activity and consciousness manages the illusion of rationality, there seems to be a plausible model emerging of free-will as broker between the probabilistic generation of a viable act, based on sensory and retained data, and the take up of that act. As Claxton suggests, what appear to be 'intentions' could be viewed as 'predictions', a suggestion of that which is about to happen but which appears to be an act of volition. It is possible to observe the malfunctioning of these processes in patients who have experienced brain damage. Conway recalls a patient whose sense of free-will was so distorted that they felt in total control of their *immediate* environment, believing that they were actively setting the sun and moving cars along the street. Other patients have experienced permanent *deja vu*, believing they have a prior recollection of all experiences. (Conway 2003). Claxton's notion of the human as bio-computer is useful here, using the analogy of top-down software architecture as a metaphor for cognitive processes and sub-processes. In this model of software development a task might be decomposed into functional units. If the functions are sequenced correctly then the software's objective can be achieved. As with Conway's patients, if the control flow is disrupted, unpredictable behavioural results will be yielded but if correctly sequenced the various sub-routines will allow the illusion of personal control and volition to be maintained.

By turning predictions into commands, self-as-instigator is really a simple subroutine, added to the bio-computer, which does not affect the latter's *modus operandi* at all, but which simply takes the glimmerings of a naturally-arising prediction, and instantly generates a 'command' to bring about what was probably going to happen anyway. (Claxton 1999) [111]

In the section entitled "Anticipation, preselection, and feedforward" (Pressing 1988), Pressing acknowledges the need for a predictive element within his model of improvisation but fails to engage with the full extent of its existence. He suggests that the notion of 'preparation' in

real-time cognitive processing is employed when the cognitive load is nearing its limit. He therefore sees the function of 'prediction' as being to minimise error rather than the modus operandi for a spontaneous creative act. This view, in some ways, represents the opposite control flow from that of Claxton, with Pressing suggesting that the predictive sub-routine is called to ease the cognitive work load rather than the sub-conscious calling consciousness as a sub-routine to accept the prediction and interpret it as an act of volition. Dennet offers an expanded view on this interface between prediction and volition. He contests that it is impossible to follow the trace of an act backwards from its manifestation in consciousness because of the amalgamation that is undertaken from the primary sensorial data and memorised referenced data. For this reason he suggests "we see the dramatic effects leaving; we don't see the causes entering" (Dennett 1984). Simmel describes the process as "an ex-post-facto intellectual transformation of the immediately given reality" and suggests that there is a seamless transformation of data from one cognitive process to another. He suggests that "because of constant habit, we achieve this almost automatically. We almost think it is no transformation at all, but something given in the natural order of things" (Simmel 1917).

2.5 Voluntary and Mechanical Behavior

Ouspensky's writing of the 1930's is surprisingly topical in the current academic climate particularly within the realm of volition and free will.

In the English language there are no impersonal verbal forms which can be used in relation to human actions. So we must continue to say that man thinks, reads, writes, loves, hates, starts wars, fights, and so on. Actually, all this *happens*. (Ouspensky 1940) [13]

Think about the question "are you growing your hair?". A natural response could be "yes" but an equally valid response could be "no, it just happens". It seems that the linguistic mechanism doesn't exist to logically express the notion that "I am not improvising, but improvising is happening". A less contentious way to formulate an expression of this type is to introduce the possibility of a negative intervention. The question, "are you allowing your hair to grow?" is perhaps less problematic although doesn't entirely express the correct

sentiment, because it still implies personal control or intervention which simply doesn't exist. It's curious that on these terms, buying into the notion that one is 'growing one's hair' isn't too far removed from Conway's patient who 'sets the sun' and 'moves the traffic'. In both cases there is a fundamental denial that consciousness sits in the passenger seat and not the driving seat; observing everything but exerting no control. As Ouspensky would have us believe:

Man cannot move, think, or speak of his own accord. He is a marionette pulled here and there by invisible strings (Ouspensky 1940) [13]

Further proof that volitional control is relinquished by human beings, particularly when undertaking processes at speed, is provided by the work of Cabrera and Milton. From analysing the movements of a hand balancing a stick they concluded that the compensating hand movements were so fast that conscious intervention in the process was not possible. They established that 98% of the hand movements required to keep a stick balancing were faster than the 100 milliseconds it takes for a human to respond to a visual stimulus. The compensating movement of the hand comprises a number of small random movements which keep the stick in a constant state of instability.(Cabrera and Milton 2003)

In piecing together the various perspectives on the evolution of a human action a model emerges that perhaps supports the idea of a diversity of mechanical behaviour. This diversity can perhaps be viewed in two schools which I will refer to as 'bio-mechanical' behaviour and 'cognate-mechanical' behaviour. Bio-mechanical behaviour can be regarded as being a collection of processes which exist on a continuum. At one extreme, physically embedded systems such as those that handle digestion and blood supply, while at the other extreme those that are more susceptible to external environmental influence such as motor control. What characterises processes on this continuum is that their execution falls outside of the conscious gaze even though their initiation may not. Cognate-mechanical behaviour on the other hand is presented to consciousness for monitoring and feedback, and as such has a greater impact on cognitive load. See Figure 2.1.

Viewing the human activity of riding a bike in this mechanistic way would reveal bio-mechanical processes taking oxygen to the lungs, exerting force on the pedals and controlling balance, while the cognate-mechanical processes determine which route is followed and how fast to proceed. It seems likely, given that the human cognitive capacity is a finite resource, that there is an efficiency incentive for cognate-mechanical processes to migrate to the bio-mechanical domain once they no longer require monitoring and feedback, thus freeing resources.

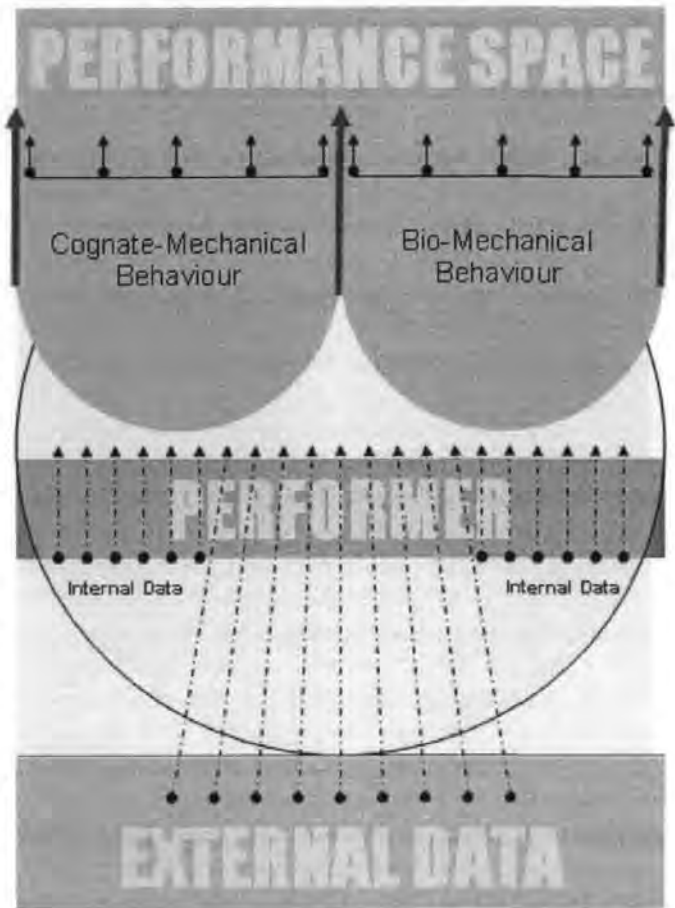


Figure 2.1

longer require monitoring and feedback, thus freeing resources. The imperative for this to happen becomes more acute as the number of cognate-mechanical processes happening simultaneously increases. This raises the issue of concurrency and inevitably the school of thought that asserts the impossibility of such an occurrence.

Is it possible to attend to two things at once? Many researchers have answered 'no' (Broadbent, 1959; James, 1890; Welford, 1976), preferring to believe that (a) one task is 'automated' while attention tracks the other task; or (b) attention alternates rapidly between the tasks (time-sharing); or (c) the two tasks are time-integrated (often by training) and reconceptualized as one task. (Pressing 1984) [356]

Whether or not true concurrency is possible is perhaps less important to the fact that multiple streams can be 'handled' in some way. The situation is somewhat akin to the majority of computer operating systems which give the appearance of concurrent multi-tasking but in fact cleverly switch processing power to each process in turn, creating the illusion of simultaneity. Pressing identifies that in accordance with the resource allocation model of cognitive

processing the migration of a process from cognate-mechanical to bio-mechanical can be initiated.

Two tasks can interfere if their total processing demands exceed existing capacity. The result of task rehearsal is thus to convert processing routines requiring conscious attention into automatic routines requiring only unconscious attention. As James said in 1890, 'habit diminishes the conscious attention with which our acts are performed' (p. 114). (Pressing 1984) [357]

There are a number of practical reasons in improvised instrumental music why this transference needs to take place. Pressing identified the speed at which acts are executed as having significant implications for which type of mechanical behaviour they are governed by. Consider that a semi-quaver played at a moderate speed of 120 beats per minute only takes around 100 milliseconds to execute. It seems that, according to Welford, the minimum time lag needed to process a cognate-mechanical act would be in the region of 400 milliseconds.

Finally it should be noted that unexpected sensory changes requiring significant voluntary compensations require a minimum time of about 400-500 ms (Welford 1976). This is therefore the time scale over which improvising players in ensembles can react to each others' introduced novelties (about twice a second). Nuances in continuous improvised performance based on self-monitoring are probably limited by error correction times of about 100 ms (Welford 1976), so that speeds of approximately 10 actions per second and higher involve virtually exclusively pre-programmed actions (Pressing 1984a). An informal analysis of jazz solos over a variety of tempos supports this ball-park estimate of the time limits for improvisational novelty. (Pressing 1988) [138]

Within the realm of improvisation this facility is of course a double edged sword. There is a trade-off that exists which has a significant effect on the improvisers ability to undertake improvisation. Transferring acts from the cognate-mechanical to the bio-mechanical sphere will undoubtedly increase processing speeds and in turn motor facility. What it also does, however, is render each act a fixed entry into a library of pre-constructed components held in object memory.

Yet at the same time that the development and training of memory is liberating it is restricting. For the improviser yields the detailed control of fast events to previous (non-spontaneous) decisions, and introduces an element of composition. Thus ... fast time-scale decisions cannot be very piece-specific; they are training-specific. (Pressing 1984) [360]

It is interesting that this dichotomy hardly exists outside of the realm of improvised music, except perhaps for speech. It is much easier to circumvent mechanical tendencies in fields such as improvised theatre because the speed imperative doesn't seem to exist to the same degree. Pressing points to the speed of the biological processes that underpin improvised music making as evidence of the fact that the field of music and the act of improvisation are natural allies.

Processing speed seems to be greatest for audition and touch/kinaesthesia, of all the possible sensory systems. These are precisely the elements involved in musical improvisation and provide a vivid psychological interpretation for the historical fact that music, of all art and sport forms, has developed improvisation to by far the greatest degree. (Pressing 1988) [137]

On a pragmatic level the need to reduce the cognitive burden of conscious monitoring at high speeds is clear, but it is still nevertheless a problematic notion for many improvising musicians. To some extent the core of the problem lies in the developmental stages of an improviser's practice. Learning to improvise has traditionally involved encoding in object memory a repertoire of musical motifs or patterns. The function of this process was not only to give the improviser a pallet of learnt material but also to develop instrumental facility. Pressing reviews a number of pedagogical approaches to the teaching and learning of improvisation and identifies one in particular that supports the notion of encoding in object memory a pallet of primitives from which can be constructed larger blocks of material appropriate to a particular idiom.

A second approach, which historically took over as the first one waned, sets out patterns, models, and procedures specific to the improvisational situation, which, if followed by those possessing a solid enough level of musicianship, will produce stylistically appropriate music. In this category fall the many figured bass and melodic embellishment texts of the seventeenth and eighteenth centuries (for example Mersenne 1635; Quantz 1752/1966; Bach 1778/1949; Arnold 1965), as well as the riff compendia and how-to-do-it books in the field of jazz (such as Coyer, et al. 1970; Slonimsky 1975; Nelson 1966). (Pressing 1988) [142]

There seems however, to be a certain amount of resentment by improvisers of this material when it appears during improvisation. That isn't to say that some improvisers don't exploit this facility and construct improvisations in a heavily stylised and idiomatic fashion. It is

probably fair to say that for some musicians there is almost an ethical principle at stake in calling a musical activity improvisation that overtly draws on 'learnt' material.

One is reminded of the opinion of master trumpeter Miles Davis that his sidemen only really got loose in the last set of the night, after they had used up all their well-learned tricks (Carr 1982). (Pressing 1988) [140]

The saxophonist Steve Lacy also falls into this category. In conversation with Derek Bailey he expresses his frustration accordingly.

Why should I want to learn all those trite patterns? You know, when Bud Powell made them, fifteen years earlier, they weren't patterns. But when somebody analysed them and put them into a system it became a school and many players joined it. But by the time I came to it, I saw through it – the thrill was gone. Jazz got so that it wasn't improvised any more. (Bailey 1992) [54]

What is interesting about Lacy's observations is the assertion that the pioneers of Jazz didn't play patterns and begs the question, what constitutes a pattern? Lacy seems to be suggesting that the formulation of patterns is the mechanism by which acts, that he regards as spontaneous, can be replicated. They are perhaps the product of an analytical process for which the primary motive is 'learning' and 'copying'. What this opinion fails to address is the possibility that the 'learnt' has to exist on some level in all musical improvisation, particularly improvisation at speed. There are issues about learning or borrowing from others or from an idiom and the ethical questions that this throws up, but it seems impossible to contemplate the notion that an improviser can develop their practice in a vacuum, without musical influence. Perhaps subscribers to this school of thought believe that true improvisation is characterised by a streaming of material from the performer's psyche without influence or contamination, an activity not unlike the Surrealists' process of automatic writing pioneered by Breton, the premise of which is now generally accepted to be neurologically impossible. (Leider 2002)

An important principle in many modern cognitive therapies is not to try to achieve a behavioural response in someone by using a negative suggestion. Telling someone not to feel frightened is likely to invoke the sensation of fear, as opposed to telling them to feel safe and

secure. Trying to *not* think about something just doesn't work. There is still a misconception amongst improvisation educators who adopt the above pedagogical approach that a simple instruction "practice your scales and patterns diligently and when you need to improvise, forget them" will somehow liberate the performer from mechanistically drawing on learnt material. Even if under the influence of a psychotropic drug a performer managed to avoid normal mechanistic behaviour, the question of what would drive and inform their response mechanisms would still exist. In Pressing's review of improvisation pedagogy he briefly discusses the notion of an 'interrupt' technique, in relation to the pioneering work of Jaques-Dalcroze in the 1920s who developed an innovative approach to teaching piano improvisation.

These include composition-like problems in rhythm, melody, expressive nuance and harmony; muscular exercises; imitation of a teacher; exercises in hand independence; the notation of improvisation just after performing it; and what may be termed an 'interrupt' technique. In this last technique the word 'hopp' is recited by the teacher, as a cue for the student to perform pre-set operations such as transposition or change of tempo during the performance.

Pressing carries on to relate this to a suggestion by Curtis Roads that the whole activity of musical improvisation could be regarded as interrupt driven. This suggestion by Roads forms only a small part of a more general paper about musical grammars but offers an embryonic idea that warrants further development. Roads places the concept of an interruption in the context of a multi-player performance "in which a phrase may be interrupted and a new phrase may begin". (Roads 1979) Although applying the concept at this macro level would possibly illuminate an examination of group dynamics and social relationships in collaborative performance situations, it does little to further the exploration of an improviser's internal mode of operation. That's not to say the concept is redundant at this level but rather that it needs reframing in terms of the streams that are being interrupted and by what. A musical interruption of the kind described by Roads is only one of a myriad of possible types of interruption that may bear influence on an improviser's behaviour. It also has to be acknowledged that such an event, however overtly initiated, may have no influence at all or may have an influence that never receives conscious attention i.e. the performer responds to a

musical interruption but is not aware of the response. Interrupt handling cannot guarantee to produce a cognate-mechanical response. In fact if an interrupt is received when the cognitive load is prohibitively high it is probably fair to say there is no guarantee of a response at all. In addition to response adjustments made in relation to cognitive load there is also the question of scheduling and prioritising interventions. If an interruption is defined as the recognition that a monitored stream of data requires some form of response, then mechanisms obviously need to be in place to handle the possibility of a number of such events occurring simultaneously. In exploring the parallel and dynamic hierarchies that exist in musical phenomena in relation to his own interactive performance system Jonathan Impett describes the nature of this complexity.

An action at a given moment in time is thus in effect the product of the modulation of many dynamical systems, all changing and interacting with their own internal dynamics. (Impett 1999) [3]

One model could relate interrupt scheduling to the notion of goal states identified by Conway (Conway 2003). If we consider the possibility that instead of existing as discrete entities, goal states are nested in accordance with a hierarchy of significance, it's then possible to conceive of a situation where one interrupt event can override another.

Consider a driver listening to a play on the radio during a long motorway journey. There are aspects of this activity which could almost be regarded as bio-mechanical, steering for instance, which requiring very little conscious attention during motorway driving. Then there is the play on the radio. For long periods of the journey the cognitive processes involved in the act of driving the car can be successfully interrupted by the detail of the narrative as it unfolds on the radio. The cognitive goal at this stage being the following the narrative of the play. As the driver passes a sign post, the 'radio play - perception' process is interrupted by the need to devote attention to the road sign as the goal of the 'journey process' has priority over the goal of 'play process'. If another car suddenly brakes then the goal of the 'survival process' will take precedence over the 'journey process' causing an action compliant with that goal state. There is scope for a much larger study than can be undertaken here into the nature

and formulation of these hierarchical networks of goal states, particularly in relation to improvising musicians. The particularly fascinating aspect of such a study would be distinguishing between those goal states that are cognisant and those that are not, and also those that are extra-musical and those that are not. Analysing behavioural traits of an improvising musician and placing their goal states on a matrix comprised of these two axioms would be a fascinating undertaking. What we are concerned with in this study however, is exploring the possibility of modes of intervention that could bear influence on the goal state hierarchy that exists when improvising musicians are practicing their art.

2.6 Subconscious Processing

Phobias are an interesting way to begin unpicking the workings of the subconscious. Psychologists such as Martin Seligman have suggested that there are three categories of stimuli which are likely to elicit a phobic response from a normally functioning human being. Broadly these are, those associated with disease, venomous or predatory animals and unfriendly conspecifics. It is curious that in the modern world, with its proliferation of potentially dangerous situations, that the human instinct provides a far stronger reaction to stimuli from our ancestral environment than our current one. This bears out Cosmides and Tooby's notion of a modern skull housing a stone age mind. Cars are now a significant threat to our well being, yet the thought of a scorpion is likely to engender more fear than that of a car. It is clear that phobic responses are not conscious responses, they occur far too quickly, and so must be processed subconsciously. The neural pathway which produces any behavioural response starts with the registration of a stimulus, which could involve any or all of our sense receptors. In the case of a primarily visual stimulus the thalamus will construct a neural representation of an aspect of the situation in the visual cortex, for instance, the appearance of a wild animal. At this point, if the interpretation of the stimulus is deemed life threatening, it is transmitted directly to the amygdala without conscious intervention. The limbic system, which is responsible for a variety of emotional responses, initiates pre-programmed units of behaviour which it draws from its repertoire, in accordance with the

situation. It is interesting that there is not an exact or fixed relationship between the interpretation of the situation and the behavioural response. In fact, the brain exhibits a type of fuzzy logic that has become known as 'sloppy pattern matching'. This allows the subconscious to respond to situations with a degree of flexibility. If a life threatening situation is encountered and survived, the brain will have subconsciously processed a vast amount of contextual information which it will store in episodic memory. This will include data from all the senses. 'Sloppy pattern matching' allows an individual to exhibit a 'fight or flight' response when a situation shares a number of characteristics with one that was potentially fatal. The disadvantage to this facility is that sometimes contextual information that is irrelevant to the severity of the situation can be encoded by association and so produce inappropriate 'fight or flight' responses in the future. Someone who almost gets killed by a car while standing next to a doughnut stand may encode an association between the smell of doughnuts and extreme danger and consequently experience panic attacks whenever they smell doughnuts.

Because consciousness is only loosely tethered to the underlying apparatus that generates fear, the intellect cannot be brought to bear on the problem. The unconscious simply won't listen, preferring instead to abide by the time-honoured adage 'better safe than sorry'. Individuals suffering from phobias may have inherited a first-class alarm system, but it is one that has now become something of a handicap in the controlled, protected environment afforded by civilization. (Tallis 2002) [136]

For good evolutionary reasons in normal waking life the control flow between conscious and subconscious processing is unidirectional. In a sense it seems as though consciousness cannot be trusted to affect processing which is deemed to be influential in achieving our 'survival' goal state. Our blood supply, digestive system, sleep patterns are all controlled subconsciously but so are many processes that allow us to interact with the world around us. Phobic responses are just one example, more common involuntary behaviours might include blushing, crying and sweating. In these cases internal psychological states are evoked in response to particular external situations. The mapping of internal state to external state has a probabilistic component to account for variations in the external state.

The library of external states is held as a collection of constituent parts which relate to sensory information. A mapping then occurs between these constituent parts and sensory data that is received. When incoming data constitutes a reliable enough 'sloppy' match with a range of components of a held state then the corresponding response can be triggered. Although many people may be aware that an external state has an inappropriate mapping there is very little that can be done to subvert it. Even though we know meeting a particular person may make us blush, when the situation arises there is nothing that we can do to prevent it. It is of course not always the case that the triggered responses are unwelcome. There are many instances where they are integrated seamlessly into our conversations, sexual encounters, arguments and even musical improvisations. Although it is true that intervening in the mapping process is impossible for most people in real time, i.e. preventing a blush, there are fields of endeavour that do allow 'off-line' access to this facility.

In clinical circles hypnosis is perhaps the most established method of cognitive intervention. This method utilises the subconscious's receptiveness to suggestive language patterns, particularly when a person is in a state of deep relaxation or 'trance'. It is commonly accepted that most people experience a range of trance states on a daily basis. The consensus seems to be that a trance equates to any state of concentration in which the subject is oblivious to other stimuli, even momentarily. That is not to say that full consciousness cannot be regained at any time. During an hypnotic induction the subject remains conscious at all times but achieves a much deeper level of trance by focussing conscious attention on their inner psychological state. The trance induction is aided by the use of a spoken script which is delivered slowly and in a low, soft tone. The script contains a range of language patterns to which the subconscious is particularly receptive. Once a trance state has been achieved various techniques can be employed to alter the mapping of psychological states to external stimuli and so affect behavioural change.

In therapeutic situations it has been possible to influence both bio-mechanical and cognate-mechanical processes that have become in some way dysfunctional. It is clear from a

mountain of anecdotal evidence that improvising musicians can sometimes enter a psychological state that strongly resembles that of trance. Stephane Grappelli offers a classic description of a trance state in relation to his own practice.

When I improvise and I'm in good form, I'm like somebody half sleeping. I even forget there are people in front of me. Great improvisers are like priests; they are thinking only of their god. (Balliet 1976)

The complete absorption in the act of improvising expressed by Grappelli has a strong parallel with Roger Elliot's description of hypnosis.

Hypnosis is simply the deliberate use of the imagination, paralleled with strong focus and relaxation. Done well, it can work in the same way as when you are dreaming. (Elliot 2003)

In a therapeutic context hypnosis can be viewed as a two phase activity, the first being the induction of a hypnotic trance and the second the delivery of hypnotic suggestion. There is no indication in any of the evidence that I have viewed to suggest that anything other than the first phase is experienced in improvised music. The indication is also that the instances of this occurrence are not volitional and are infrequent. Sloboda implies, in his observation of Jazz improvisation, a duality of conscious state which gives the performer the facility to create acceptable and functional material in between periods of more intense creativity.

The jazz improviser can enjoy his improvisation because he knows that there will always be something he can play. Within this competence he, like all improvisers, knows that for much of the time he will produce quite ordinary improvisations; but from time to time, according to circumstance of mood and choice, something superlative will come up. (Sloboda 1985) [148]

There is no clear evidence to indicate what circumstances trigger this change in cognitive state or if this is a type of induction. There is however an interesting correlation between the sense of disorientation experienced by improvising musicians when they find themselves playing outside of their normal terms of reference, and the use of deliberate disorientation as an established technique during hypnotic induction. The following accounts seem to describe such a situation from both perspectives.

When using hypnosis, we primarily want people to stop thinking so much (conscious mind) and go with the flow a little more. Some people find this difficult and so it can be useful to use slightly confusing language to 'trip up' the conscious. (Elliot 2003)

A lot of improvisers find improvisation worthwhile. I think, because of the possibilities. Things that can happen but perhaps rarely do. One of those things is that you are 'taken out of yourself'. Something happens which so disorients you that for a time, which might only last for a second or two, your reactions and responses are not what they normally would be. You can do something you didn't realise you were capable of. Or you don't appear to be fully responsible for what you are doing. (Bailey 1992) [115]

It can make a useful change to be dropped into a slightly shocking situation that you've never been in before. It can produce a different kind of response, a different kind of reaction. (Bailey 1992) [128]

Bailey here quotes Evan Parker describing as 'slightly shocking' the feeling of relinquishing conscious control as a performance moves into territory in which his 'sloppy pattern' matching processes cannot retrieve an appropriate response quickly enough to deliver it to his consciousness. In Rouget's examination of music and trance from 1967, he cites the observations of Alain Danielou describing mystic dances from Southern India which has remarkable similarity to the situations described by Bailey and Elliot.

The dancers are first of all drawn into an easy rhythm with which they identify completely and thus sink into a sort of hypnotic half-sleep. The musicians then create a shock by means of several violent drum strokes and embark on a new, much more complex rhythm. After hesitating an instant, the dancers are taken over by this new rhythm without even consciously willing it. In some of them, this provokes a trance state and a complete loss of self control, as though the rhythm were a kind of spirit that had possessed them. This trance state is characterized by insensitivity to pain, complete loss of modesty, and visionary perceptions. (Rouget 1985) [81]

The significant difference in this situation being that the musicians evoke the trance state in the dancers and do not enter the trance state themselves. This point is generalised by Rouget in terms of his analysis of worldwide ritualistic trance music by regarding the musician as having a functional relationship to the activity of trance induction. His view of their 'job' as to be "constantly available and at the service of the ritual". (Rouget 1985) [104], deviates from the view of the musician in this study but none the less provides insight into the use of hypnotic techniques within a musical context.

Steven Nachmanovitch describes, from a musician's perspective, experiencing a sensation when musical behavioural response is no longer revealed to him consciously. The situation he describes parallels the Miles Davis observation cited earlier in this paper (page33) describing what happened to the players in his band when all their 'licks' were used up.

Time after time my best music comes when I feel that the material is played out; I am at the end of my resources, and the piece had better end before I make a fool of myself. So I grope toward a closing phrase, and finish-but somehow, despite my intent, the bow refuses to stop! The cadence or whatever ending I contrive modulates into something else, and out of nowhere comes a totally new melody. I feel in my blood, my bones, my muscles, brain, a wholly new and unexpected surge of energy. This is the second wind. Time doubles and triples over on itself; I disappear and the music really starts to cook. My feeling is invariably one of wonderment: "how in hell did *that* happen? I didn't know I had *that* in me!" Suddenly we, the players and the listeners, find ourselves elsewhere; the music has *moved* us. (Nachmanovitch 1990)

It is almost definitely not the case that Nachmanovitch or Davis's band have managed to circumvent the brain's automatic response processes but what they are experiencing is their responses changing from cognate-mechanical to bio-mechanical. It is hard to determine exactly what causes this change but it is perhaps significant that they and others seem to describe this phenomenon in the later stages of a performance. We know that cognitive resource limits can affect those responses that are made conscious and those that are not, so it can perhaps be surmised that the pressure not to repeat material and fatigue could tip the balance towards the end of a performance. As Calvin identifies, it is clear that at a primitive level the musical material that will be produced, after consciousness has been circumvented, is unlikely in itself be new.

Innovative behaviors are usually not new units; instead, they are composed of a novel combination of old elements: a different stimulus evokes a standard behavior, or some new combination of movements is used in response. How is sensory/movement innovation related to intelligence? The sheer quantity rebuilding-block types could be important. (Calvin 1996) [19]

If then, as has been suggested, conscious decisions are controlled and initiated by the subconscious, the question has to be asked; does this trance type state make any difference whatsoever to the performance? It certainly seems to have a significant effect on the perception of the performers but there is nothing to suggest that this is a reliable indication of

a successful performance. Indulging in chemical 'enhancers' can produce a sense of euphoria in a performer while having a negative effect on the performance of which the performer is oblivious. Composer and improviser Pauline Oliveros questions the premise that improvisers are operating at the limits of cognition. Her concept of quantum improvisation defines a vision of musical improvisation as means of realising the latent potential of the brain.

Such a quantum leap could mean the utilization of more of the neo cortex the seat of creativity and problem solving. The newest part of the brain that is waiting to evolve in association with the limbic system - the amygdala - old brain and seat of the emotions. Quantum Improvisation could find new ways to express and understand the relationships between mind and matter. (Oliveros 1999)

In fact her vision blurs the distinction between conscious and subconscious within the realm of improvisation. Describing, in her terms, improvisation as a fluid endeavour that ebbs and flows between bio-mechanical and cognate mechanical behaviour. Her scores and scripts exemplify her notion of a strategy, implying and embracing the idea that consciousness is not the driving force.

Chapter 3 - Improvisation and Communication

3.1 Language and Spontaneous Thought

To cast light on the probability or possibility of a human being possessing the facility to spontaneously and consciously manufacture novel thoughts in a musical context, it is useful to consider the domain in which those thoughts may become manifest. In doing so it is worth examining certain aspects of spoken natural language as this is perhaps a domain with a significant amount of commonality with musical improvisation. We use spoken language to express ideas and in that sense it is a vehicle for the internal to become external. There is no question that a representation of natural language can exist internally before it is expressed, a manifestation of which can be witnessed in the mutterings and mouthings that people undertake to themselves. We cannot conclude from this however, that ideas are formulated using the symbols and nomenclature of spoken language, just that they end up in that form in order for the idea to be externalised. There are at least two reasons to suggest why thoughts are not formulated using natural language. Firstly, thinking in animals other than humans is now an accepted phenomena which has no causal link to a spoken language:

Animals recognize different agents and their interactions and the causal links between ongoing processes connecting them. We have now plenty of examples of mental representation possibility and of generalization, categorization and causal reasoning...There is now strong indication that chimps even succeed in forming mental representations of the knowledge present in the mind of another subject. (Vanechoutte and Skoyles 1998) [6]

As previously discussed in chapter 1, this reasoning would also deny the existence of the ability to think in pre-linguistic children. In formulating his conclusions on the studies undertaken into ape language Vygotsky emphatically concludes that speech and thought in human beings is likely to emanate from separate origins, and that speech almost certainly originated as an emotional rather than an intellectual expression.

In the phylogeny of thought and speech, a prelinguistic phase in the development of thought and a preintellectual phase in the development of speech are clearly discernible. (Vygotsky 1962) [41]

The second, pragmatic reason is that the human brain does not have the capacity to formulate language in real time at the rate that it spawns original ideas. The overhead of constructing completely original utterances would be far too great, as Pinker alluded to when he identified the 6.4 trillion possible choices in constructing a five word sentence (Pinker 1999) [6]. This leads to the conclusion that natural language is used to provide a best fit expression of the idea rather than the primary mechanism for formulating it. This expression offers a very quickly constructed equivalence built from pre-used chunks of language. The analogy of language production as the packing plant for expression is perhaps appropriate. It receives items for expression which are placed into the most appropriately sized and constructed containers. If the number of containers is increased in an effort to provide a more direct mapping to each item, there becomes a point when diminishing returns will impact on the efficiency of the packing process. The range of choices become burdensome and the overhead of parsing the range of choices outweigh the benefits of producing a tighter match. Pinker refers to Miller's conservative estimate of the potential number of choices available in the construction of a standard English sentence.

If speakers keep a sentence perfectly grammatical and sensible as they choose their words, their menu at each point offers an average of about ten choices (at some points there are many more than ten choices; at others, only one or two). That works out to one hundred thousand five-word sentences, one million six-word sentences, ten million seven-word sentences, and so on. (Pinker 1999) [7]

Pressing presents a view of the 'packing' process but from the perspective of improvised music. Interestingly he introduces a substratum of the packing process which simplifies the range of possible choices by employing a schema which in this example is diatonic harmony. He is describing chunking as an aide memoire rather than an aid to the expression mapping but nonetheless demonstrates the need to employ such techniques to lighten the cognitive load.

Few, if any, performers can take all of a sequence of, say, 15 newly-presented notes not arranged in any standard sequence and improvise successfully with them. There are just too many independent variables. Of course, if these notes can be conceptually 'chunked' into larger groupings, this statement is no longer true. For example, if each adjacent group of 3 notes belongs to a different major chord, played in a consistent

order, then only 5 objects must be memorized and the experienced improviser would have no difficulty in manipulating the material. Without knowledge about theory, musicianship, repertoire and technique the limits of short-term memory would make sophisticated musical development and impressive technical displays impossible. (Pressing 1984) [360]

By implication then, in the spontaneous creation of spoken language, the conscious choice humans make is not 'what to say' but 'how to say'. Derrida's observations are particularly revealing and could find equivalence in a whole range of contexts.

Conversation is, then, a communication between two absolute origins that, if one may venture the formula, auto-affect reciprocally, repeating as immediate echo the auto-affection produced by the other. Immediacy is here the myth of consciousness. Speech and the consciousness of speech - that is to say consciousness simply as self-presence - are the phenomenon of an auto-affection lived as suppression of difference. That *phenomenon*, that presumed suppression of deference, that lived reduction of the opacity of the signifier, are the origin of what is called presence. That which is not subjected to the process of difference is *present*. The present is that from which we believe we are able to think time, effacing the inverse necessity: to think the present from time as difference. (Derrida 1967) [166]

The notion of 'auto-affection' could equally be applied to an orator speaking to a single person, a crowd or indeed to themselves. It is the absorption in the act of 'expression mapping' that leads to what Derrida describes here as the consciousness of self-presence, the illusory standpoint from which to view time. It is however, the 'auto-affection' that remains outside the bounds of conscious control but nonetheless seeds the process of spoken language production. The 'auto' aspect of this phenomenon could undoubtedly be unpacked into a variety of subconscious and subliminal influences each with their own sophisticated parameter space making them resistant to accurate prediction and so masking the 'auto' aspect of their 'affect'. Predictable or not, there is no rational justification to support the notion that they are initiated or controlled consciously. Lechte comments on this relationship in reference to Lacan's work.

By implication, then, the unconscious cannot be assimilated by the consciousness system, but rather poses a problem for consciousness because it cannot be represented: *it* speaks. Or in Lacan's words: 'there is no metalanguage'. There is no discourse over and above discourses of the consciousness system (such as the scientific) which can represent the unconscious. On the contrary: *it* appears. (Lechte 1990)[35]

The assertion presented by Lechte that the facility doesn't exist in human beings to consciously form a direct representation of the unconscious, seems to support the notion of the 'expression mapping' function of spoken language which has been developed. It does however appear to conflict with current theories in cognitive science which concur with the notion that communication between the two areas is always uni-directional, from subconscious to conscious. Although there are very good biological reasons why this is the case for the vast majority of the time, it is also the case that this communication flow can be reversed in certain situations. *Hypnosis and cognitive behavioural therapy* are two disciplines that have direct relevance in this area. As the model we are examining here is one where spoken language is being used in a natural and unaffected manner, it is perhaps not that helpful to examine in detail the capacity of traditional hypnosis to facilitate conscious/subconscious communication. The reason for this omission being, that traditional hypnosis is undertaken while one person engaged in the discourse has been induced into a trance state by the other. However, the work of Milton Erickson in this field is worth considering as his therapeutic practice blurred the edges between ordinary therapeutic discourse and hypnotic discourse.

In many instances Erickson used standard, client centred hypnosis in his therapeutic practice. There are however many accounts of Erickson's work which refer to his ability to treat patients hypnotically but without visibly inducing in them a trance state. He used this technique in a variety of situations including those involving patients resistant to hypnosis. This practice usually involved the use of metaphorical stories, for which Erickson became famous.

Milton Erickson is a master in the field of metaphor. In the way he listens to and observes a subject, as well as in the way he responds, he deals with the multiple metaphoric messages that are constantly communicated between people in their interchange. He functions as easily in metaphor as most people function with conscious, logical communication. His directives to patients are not often simple and straight forward but include a variety of analogies that apply to the patient's problem. The metaphoric approach he uses when not formally using hypnosis is clearly related to his years of experimenting with metaphoric suggestions outside the awareness of the subject. (Haley 1973) [27]

Viewing this practice in the context of Derrida's conversation between "two absolute origins" that "auto-affect reciprocally" (Derrida 1967), one can see the potential in Erickson's technique to intervene in the dialogic flow. What Erickson's intervention allows is the possibility to remotely affect a person's auto-affect response. Although this is initiated via spoken language, the auto-affect is not confined to a linguistic response; Erickson successfully affected a range of behavioural traits. One key aspect of Erickson's work that sets him apart from many of his contemporaries is that, as far as possible, he confines his discourse to the metaphorical domain and purposefully offers no interpretation of the metaphor to the client. Erickson was so skilled in this type of communication that he was able to interpret his client's responses metaphorically, even if the responses were non linguistic.

Although Erickson communicates with patients in metaphor what most sharply distinguishes him from other therapists is his unwillingness to "interpret" to people what their metaphors mean. He does not translate "unconscious" communication into conscious form. Whatever the patient says in metaphoric form, Erickson responds in kind. By parables, by interpersonal action, and by directives, he works within the metaphor to bring about change. He seems to feel that the depth and swiftness of change can be prevented if the person suffers a translation of the communication. The avoidance of interpretation applies not only to the verbal statements of patients but to their body movements. Erickson is famous for his acute observation of nonverbal behaviours but the information he receives remains nonverbal. (Haley 1973) [28]

Using this technique, he could deliver a complete course of therapy without making the patient consciously aware of the therapeutic change that had taken place. There are accounts of patients being unaware that behavioural change had taken place because of the subconscious manner of its execution and returning to Erickson's practice to complain about the ineffectiveness of the treatment. Erickson represents a departure from the traditional therapeutic premise that behavioural change requires in the patient an understanding of the causes of their behaviour.

In the last decades the conditioning therapists have proposed an alternative theory of change. Reciprocal inhibition procedures and the modification of behaviour by designed reinforcements are not based upon the idea that becoming aware of why one behaved as one does is causal to change. It is assumed that changing the reinforcements of behaviour will change that behaviour. Therefore it has become more respectable to suggest that therapeutic change occurs without the person's

understanding the meaning or function of his behaviour. The change also appears to persist longer than it does when people are helped to understand why they believe as they do. (Haley 1973) [38]

This departure falls in line with the notion that conscious awareness or consideration is probably the least efficient mode in which to interact with the world around us. It certainly exemplifies the 'expression mapping' dilemma identified by Lechte in regard to the unconscious in that "it cannot be represented: *it speaks*".

There is a curious connection between Erickson's ability to provoke behavioural change in a patient who is oblivious to the reasons underlying their original behaviour and the modes of thought described here by Claxton. In particular, a parallel can be drawn between the metaphorical or hypnotic delivery of a suggestion or instruction and the self initiated recourse to a mode of thinking which is purposefully non-conscious, named by Claxton 'tortoise mind'.

Recent scientific evidence shows convincingly that the more patient, less deliberate modes of mind are particularly suited to making sense of situations that are intricate, shadowy or ill defined. Deliberate thinking, d mode, works well when the problem it is facing is easily conceptualised. When we are trying to decide where to spend our holidays, it may well be perfectly obvious what the parameters are: how much we can afford, when we can get away, what kinds of things we enjoy doing and so on. But when we are not sure what needs to be taken into account, or even which questions to pose – or when the issue is too subtle to be captured by the familiar categories of conscious thought – we need recourse to the tortoise mind... This third type of intelligence is associated with what we call creativity, or even 'wisdom'. (Claxton 1998) [3]

What Claxton describes is the conscious initiation of a cognitive process which once commenced is cut free from conscious control and left to run its course, from which it will return to consciousness once the process has been completed. Claxton is suggesting that non mechanical tasks are best suited to this mode of thinking because once the overhead of consciousness has been removed, greater cognitive capacity is available for the process in hand. The reasoning behind why the processing of information from 'ill defined' or 'shadowy' situations should be more burdensome could be explained in relation to the 'expression mapping' concept previously developed. Any translation process will be more arduous if the correlation between the various elements in the process is vague. Mappings

and re-mappings need to take place before an appropriate best fit is achieved. In theory expressing a preference between one's parents should be no more difficult than expressing a preference between tea or coffee, a simple binary choice. In reality the likelihood is that the latter choice will be undertaken in a deliberate manner as the sentiment that is presented for expression will be clearly and unambiguously mapped onto appropriate expression elements. The former, if attempted consciously, would be likely to require a much greater cognitive undertaking to find an expression mapping that would not be vetoed by the subconscious. This transition from unexpressed to expressed is perhaps related to the duality of signifier and the signified associated with the Saussure tradition.

Its system requires that it be heard and immediately by whoever emits it. It produces a signifier which seems not to fall into the world, outside the ideality of the signified, but to remain sheltered - even at the moment that it attains the audiophonic system of the other-within the pure interiority of auto-affection. It does not fall into the exteriority of space, into what one calls the world, which is nothing but the outside of speech. Within so-called "living" speech, the spatial exteriority of the signifier seems absolutely reduced. It is in the context of this possibility that one must pose the problem of the cry - of that which one has always excluded, pushing it into the area of animality or of madness, like the myth of the inarticulate cry - and the problem of speech (voice) within the history of life. (Derrida 1967) [166]

Derrida describes here the moment of expression without reducing it to a process of correlation, but what is interesting is the relationship he evokes between the sonification process and the process of auto-affection. He seems to be relating this to the interior - exterior threshold of expression, and in so doing presenting an additional mode of expression that comprises the signifier and signified that has only an internal manifestation. This suggests the possibility of a 'signifier' existing and being expressed in the absence of a 'signified' and that this could relate to a primal expression, such as a cry.

3.2 Primal Utterances

It is, at this point, perhaps worth viewing the distinction between verbal and vocal expression in the light of Derrida's observation. One could extrapolate from a cry a whole range of vocalisations for which, at expression time, there is no symbolic aspect to their manifestation. Laughing, groaning, coughing are vocalisation examples which have signifiers which relate to

that which is signified only as an objectified act. The various aspects of a person's laugh can be discussed, and in such a situation the objectified laugh becomes subject to the signifier/signified mechanism. A spontaneous laugh on the other hand is not a symbolic expression, it is an expression of something, and as such relates to a signifier but has not been encoded in a symbolic form. I am careful to describe the laugh as 'spontaneous' because of the distortions to this notion that 'forced' or 'affected' laughter would cause. It is possible for a laugh to be executed in a manner that is more verbal than primal, for the expression of irony for example, and in that sense it becomes a signified utterance.

In returning to the idea of language as the 'packing plant' for expression, it becomes apparent that for expressions of a primal nature, excursions into the 'packing plant' are not undertaken. There are obviously good evolutionary reasons for this phenomenon, in a life threatening situation encoding a scream into language is a luxury that cannot be afforded. Expressions of this nature are not confined to vocalisations, physical gestures such as smiling and flinching also operate in a similar fashion. Although it is clear that these primal expressions predate symbolic languages, it could be surmised that it is perhaps the non-spontaneous fabrication of these gestures that became the precursor to symbolic language and that their legacy exists to this day in non-symbolic modes of expression.

Other forms of non-verbal communication include dance and music... All of these arts seem to be about as old as man. Actually, their elementary forms must be even older, since the imitative, representing function of gesture and mimics must have been used for tens of millennia before human symbolic language with highly specific articulation developed. Indeed, the most ancient musical instrument (a flute) to be discovered to date is estimated to be between 40,000 and 70,000 years old, which is older than the estimated age of human speech. (Rosengren 2000) [40]

As Rosengren has identified, there is a possibility that instrumental music predates human linguistic ability and if this is the case then there must surely be a compelling argument to suggest that vocal or physical music of some sort existed even prior to this. It is perhaps ironic that anecdotally practitioners use language as an analogy with which to describe and understand the processes at work within the context of improvised music. John Zorn's

description reduces the process to accessing a library of symbols which embody consensual understanding amongst the participants.

The analogy with language, often used by improvising musicians in discussing their work, has a certain usefulness in illustrating the development of a common stock of material – a vocabulary – which takes place when a group of musicians improvise together regularly. (Bailey 1992) [106]

Berliner on the other hand sees the grammatical aspect of languages as a connection point with improvised music.

Perlman and Greenblatt (1981, 169) have also been intrigued by this notion and state that the improviser's "specific harmonic and melodic constraints . . . are in many ways analogous to the syntactic and semantic constraints of natural language and that playing an improvised solo is very much like speaking sentences?" (Berliner 1994) [794]

The irony of these observations lies in the assumption that improvised music can be understood in terms of language rather than language being understood in terms of improvised music. It is perhaps an indication of how much language has been assimilated into other modes of expression, thus preventing an engagement with those modes without recourse to symbolic representation. The old adage 'talking about music is like dancing about architecture' is supposed to represent the absence of a correlation in nomenclature, but actually illustrates the dichotomy of describing something using a vernacular when the vernacular is derived from that which is being described.

Not all practitioners describe the relationship between language and improvised music in this way. It is almost inconceivable to express in spoken and written language notions of expression that are exterior to language, and for that reason anecdotal evidence from practitioners tends to recourse to the hierarchy of representing musical improvisation in terms of spoken languages. This hierarchy seems to be maintained even when, as with Max Roach, the interior dialogue evokes a climate where Derrida's "spatial exteriority of the signifier seems absolutely reduced".

It's like language: you're talking, you're speaking, you're responding to yourself. When I play, it's like having a conversation with myself. Max Roach (Berliner 1994) [192]

Berliner cites another metaphorical representation of improvisation as spoken languages and in particular describes a form of internal dialogue.

For Lonnie Hillyer, as for Max Roach, improvising "is really like a guy having a conversation with himself." Hillyer sometimes thinks of himself as "making statements and answering them" when he performs. (Berliner 1994) [192]

These anecdotes pose an interesting question about natural languages' ability as a tool with which to encode notions of this type. Superficially both of these accounts convey meaning related to the practitioner's perception of what they do but simultaneously they are nonsensical; referring to "a conversation with myself" is a negation of the act of conversing. In a sense, the act of trying to force notions into metaphors that don't fit, render that expression vacuous. Inevitably its only value resides with itself and not in that which it is intended to represent. What we witness in anecdotes such as these is in fact nothing more than a struggle, an attempt at expression doomed to failure and although the product of this struggle is material of interest on many other levels, it fails to fulfil its primary purpose.

Kenneth Gergen's notion of the 'relational sublime' can perhaps offer another interpretation of how a relationship between spoken language and musical improvisation could exist. Gergen points to deeper structures that exist below the encoded transmissions of spoken natural language, structures open to more primal interpretation.

Yet, although this realm of the sublime cannot be captured in language, we can appreciate its dimension. How are sounds and markings converted to what we take to be language? For how does language acquire its intelligibility? Here we must envision primordial processes of relationship – the pulsing coordination of movement and sound – that slowly turn the amorphous into the meaningful. (Grodin and Lindlof 1996) [138]

A parallel can perhaps be drawn between that which is 'primordial' in Gergen's 'relational sublime' and the 'deep structures' of Chomsky's 'transformational grammar'. The innate capability of the mind to formulate grammars which Chomsky saw as a substratum of human communication seems to relate to Gergen's belief in the relationship as the bonding layer

below natural language, in so much as they exist universally and are innate. The suggestion is therefore that we come into this world pre-loaded with the facility to interface onto any cultural language that we happen to be born into, as Fodor acknowledges, when we are born our minds are not a clean sheet.

My view is that you can't learn a language unless you already know one. It isn't that you can't learn a language unless you've already learned one. (Fodor 1978) [65]

Fodor's metaphor of the internal state of the human mind resembling that of a computer allows us to draw the analogy between machine code and the human internal language, both of which require a compilation process in order to interpret external communication. In the case of the human, the external language is of course learnt and is translated at run time rather like an interpreted language.

When you find a device using a language it was not built to use (e.g. a language that has been learned), assume that the way it does it is by translating the formulae of that language into formulae which corresponds directly to its computationally relevant physical states. This would apply, in particular, to the formulae of the natural languages that speakers/hearers learn, and the correlative assumption would be that the truth rules for predicates in the natural language function as part of the translation procedure. (Fodor 1978) [67]

What is suggested then is that human communication comprises two levels of interpretation, one external and one internal. The external level dealing with a culturally defined natural language and the internal dealing with biologically defined 'language of thought', as Fodor describes it. Fodor argues that the notion of human beings thinking in natural language is impossible for the reasons described at the beginning of this chapter.

One way of describing my views is that organisms (or, in any event, organisms that behave) have not only such natural languages as they may happen to have, but also a private language in which they carry out the computations that underlie their behaviour. (Fodor 1978) [68]

If Chomsky's 'transformational grammar' concept could be applied to improvisation, the process is likely to be fraught with difficulties. It is perhaps easier to conceptualise a situation in spoken language where the truth rules for predicates in the surface structures have a correlation with internal states in the deep structure. It is impossible to conceptualise and

express such a situation in improvised music without retorting to a symbolic representation using natural language. In the study of the 'internal language' Fodor suggests that perhaps it is not necessary to try to determine exactly what the correlation is between inner and outer language, but that it suffices for that correlation to be consistently undertaken. This relieves the improvising musician of the onus to define what might be called the 'deep structures' of his performance in any other terms than those in which they are originally manifest.

Notice that the use of a language for computation does not require that one should be able to *determine* that its terms are consistently employed; it requires only that they should in fact *be* consistently employed. (Fodor 1978) [70]

Chapter 4 - A Model of Improvisation as Human Behaviour

In Fodor's later work he proposes a theory in which the mind consists of informationally encapsulated, 'low-level' perceptual modules which feed information to 'higher-level' non-modular cognitive processes. (Zawidzki) Sperber develops this concept, (Sperber 1996), by introducing the idea that cognitive processes may also be modular and suggests also that they could become inputs to other cognitive/conceptual modules, breaking with Fodor's proposal that perceptual modules were the only feed to conceptual modules. Sperber seems to suggest that the evolving nature of conceptual modules required their reuse in the development of new modules. In a situation akin to computer software development, it would be highly inefficient to construct a new module from scratch if the output from an existing module could be utilised in its development. Sperber suggests that one such development could provide an insight into early human vocalisations.

The possibility that springs to mind is human vocal communicative sounds. It need not be the sounds of Homosapiens speech, though. One may imagine a human ancestor with much poorer articulatory abilities, relying more than modern humans do on rhythm and pitch for the production of vocal signals. In such conditions, a specialized cognitive module might well have evolved. (Sperber 1996) [141]

He suggests further that even after the development of human speech, the primary cognitive modules remained intact providing the basis for human musical sensibility. Furthermore, he proposes that in its original use this module would have been optimised to accept as its input, a very low quality and hard to discern sonic input from man's early vocal facilities, but is now being "stimulated to a degree that makes the whole experience utterly addictive". (Sperber 1996) [142]

Although the human evolutionary dynamic, moving from the reflex response to the learned, seems to favour the development of natural language rather than that of improvisation, it seems safe to assume that early humans were musical before they were linguistic. Although the internal operation of the brain then was significantly different than from now, the possible

existence of this pre-linguistic cognitive module could explain why the ability to sonically create spontaneous non linguistic expressions seems to have been retained.

The evolutionary change did not exclude emotion but tempered it. Man did not abandon the pleasures of satisfying his needs. Instead he learned to postpone them in the interest of long-term objectives. (Gurney 1973) [42]

Improvising musicians can therefore be indulged in their internal dilemma between the learned and the invented, because they are it seems caught between the need to satisfy a pre-linguist urge for sonic self-expression and the brain's modern day urge to suppress reflex response.

4.1 Processing Referents

Sperber's division of cognitive processes into the perceptual and conceptual, in the context of an improvising musician, leads to an interesting perspective on the range and causal affect of influences, both internal and external that come to bear on this practice.

Abstractly and roughly at least, the distinction between perceptual and conceptual processes is clear. Perceptual processes have, as input, information provided by sensory receptors and, as output, a conceptual representation categorizing the object perceived. (Sperber 1996) [120]

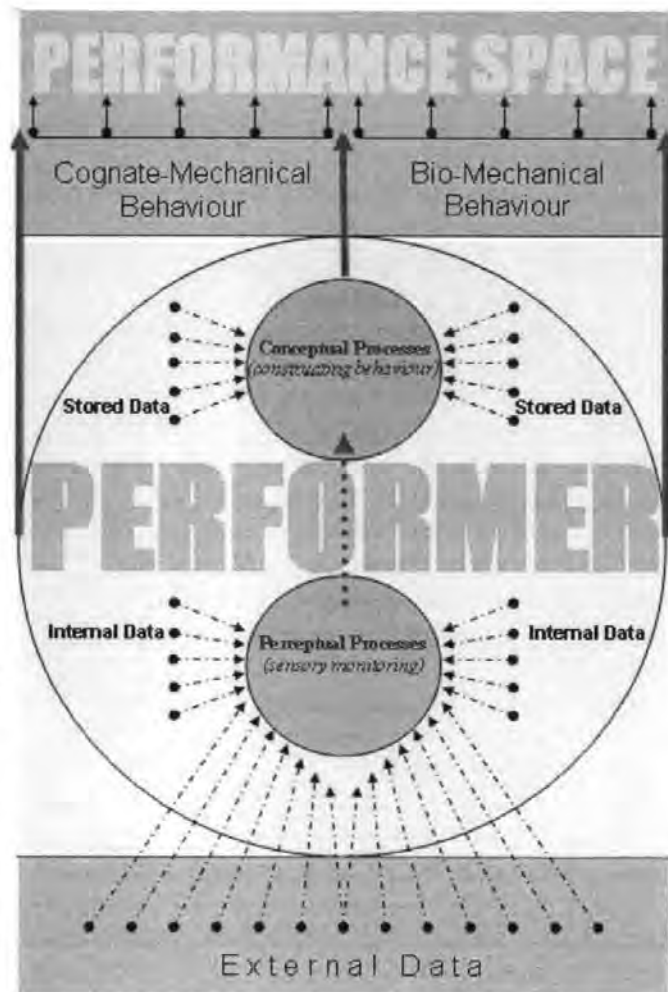


Figure 3.1 Performers Parameter Space

Figure 3.1 shows how this model can

be applied to an improvising musician sited in a performance situation.

The notion that perceptual processes have as their input the continuous data stream of sensory information and that the product or outputs from these processes become inputs to conceptual processes, can be used to formulate a model of human behaviour. A model where the parameter (sensorial) space in which the behaviour exists is split between the internal and the external. The parameters influencing the outputs of conceptual processes, those that manifest themselves as human behaviour, exist either as a result of another conceptual process or as a result of a pre-processed external data stream. Berliner alludes to one small aspect of the external parameter space when he describes a performer's response to the physicality of sound.

The body plays an even more active role when, through its motor sensory apparatus, it interprets and responds to sounds as physical impressions, subtly informing or reshaping mental concepts. (Berliner 1994) [190]

In non-scientific terms Berliner's description has an uncanny parallel with Sperber's model of perceptual processes feeding conceptual processes. The interface between these processes seems to provide the domain in which Pressing's notion of the 'referent' exists. Pressing acknowledges the role of external influences in shaping a performer's improvisational behaviour although he includes a 'speed' caveat which proposes the diminishing influence of the 'referent' as speed of execution increases.

Central to improvisation is the notion of the 'referent'. The referent is an underlying formal scheme or guiding image specific to a given piece, used by the improviser to facilitate the generation and editing of improvised behaviour on an intermediate time scale. The generation of behaviour on a fast time scale is primarily determined by previous training and is not very piece-specific. (Pressing 1984) [346]

There seems implicit in this interpretation of the effects of speed on a performer's behaviour, a fundamental flaw if one is to subscribe to the notion that the performers external monitoring system is in some way subservient to the retrieval of stored information. What this interpretation fails to acknowledge is the distinction between conscious and subconscious processes, the manifestation of which we have referred to in this study as 'bio-mechanical' and 'cognate-mechanical' behaviour. The animalistic facility humans possess to engage in background sensory monitoring must surely suggest that 'referent' parsing can take place

outside of conscious awareness in such instances when cognate-mechanical processing is taking place. Just because a performer becomes too preoccupied with an aspect of the performance to be aware of the external influences coming to bear, it doesn't render them any less influential. Although the notion of a 'referent' is not incongruous with Sperber's model of perceptual and conceptual modules, the narrow interpretation offered by Pressing of what can constitute a 'referent' probably is.

The relationship between improvised behaviour and referent is variable. It may be imitative, metaphoric, allegorical, antagonistic, canonic, contrapuntal, variational or independent, just to mention a few possibilities; and the time scale for behavioural response may vary from very short to long. In strict improvisation contexts compatibility between referent and behaviour is continuous, in freer contexts the expressive continuity of the improvised material may cause temporary abandonment of the referent. (Pressing 1984) [348]

If we use the theory of 'goal states' previously examined in this study as a means of determining what might constitute a 'referent', the notion may become more useful in the analysis and mapping of a performance parameter space. Of course the examples that Pressing cites are valid as would be many more of this type but they are all specifically music referents and all exist within the conscious awareness of the performer.

The previous chapter touched on Conway's concept of goal states in the encoding of memories. There is perhaps an overlap between this use of the goal state concept and the way it may be applied to the processing of referent information. The idea of nested goal states is as appropriate here as the 'driving' example used in the last chapter. It is true that in one particular performance context the most immediate goal state, after the tonal quality of the sound, might be to conform to a consensual form or protocol that exists between a group of performers. There may also simultaneously coexist goal states requiring the monitoring of 'referent' information of which the performer is not cognisant but which may accordingly influence the performance.

It is quite possible that many of the goal states that comprise an improviser's practice are in fact non musical. After all, improvising performers do not cease to be mothers, brothers,

priests or drug addicts for the duration of their performance. It is also perhaps too simplistic to create a duality of 'referent' information, that which is perceived and acted upon and that which is acted upon and not perceived. There seems also the possibility of a conscious act resulting from 'referent' information but without consciously understanding why the act should occur. In the production and consumption of music generally, human behaviour is perhaps governed by what we *know* rather than by what we *understand*. It is a cliché to describe consumers of art products in these terms but rarely is this notion applied to art producers.

Within the context of musical improvisation and particularly within the genre of jazz, many great performances have taken place by performers who know what it takes to move an audience. Many academics and observers have deconstructed and analysed performances in order to understand what was produced by the performer and have succeeded in representing the material in accordance with particular analytical methods, but this does not address why a performance has the effect it does. A performer can often deduce *what* has an effect but not *why*, a behavioural influence which Alain Danielou, cited by Derek Bailey, identifies as sometimes being detrimental to a performance.

Alain Danielou, writing about the difficulties for Asian musicians working within the Occidental entertainment system describes exactly the problem which has also affected Western performance musics such as flamenco, jazz and, increasingly, 'free' music. 'When the musicians note a positive reaction from the public, they are tempted to reproduce the effect which provoked this reaction and consequently one can understand how a rapid deterioration of the music performed could occur. The musician becomes little more than an actor who repeats his tricks when he notices that the public reacts favourably. (Bailey 1992) [44]

Therefore, 'referent' data is processed by perceptual modules, passed as parameters to conceptual modules which may then result in either bio-mechanical or cognate-mechanical behaviour. In the latter case, the performer may be aware of the response that has been provoked but may not understand why it has been provoked, even if a causal path is evident. The conceptual modules that are evoked in this process almost certainly do not rely entirely on perceptual modules for their inputs. It is acknowledged by Forder and Sperber that inputs

to conceptual modules can be output from other conceptual modules, thus realising efficiency gains and increasing cognitive capacity. I would therefore suggest also that this model would stand the possibility of 'referent' data being derived not only from sensory monitoring but also from the retrieval of stored data.

Moreover, within the artist's personal store of knowledge, these differing elements can each carry associations that influence the performance of subsequent ideas: harmonic qualities suggesting lineages with particular harmonic synonyms, rhythmic elements evoking other patterns with similar configurations, and yet other features invoking figures with comparable contours, phrase lengths, compatible moods, or finger patterns. (Berliner 1994) [195]

Pressing asserts that it is not possible for an improvising performer to construct a performance out of material that has not been previously learnt. Indeed it is hard to imagine a context in which either internal or external 'referents' didn't exist in a performer, if they have the capacity to learn and the capacity to sense.

There is a continuum of possibilities between the extreme hypothetical limits of 'pure' improvisation and 'pure' composition. These limits are never obtained in live performance because no improviser (even in 'free' improvisation) can avoid the use of previously learned material, and no recreative performer can avoid small variations specific to each occasion. (Pressing 1984) [346]

Let us not forget that learning need not always be reconstituted by the conscious mind, muscles and tendons are equally adept at utilising this resource. The output of a conceptual module may not manifest itself as a consciously initiated action, it may occur directly as a muscle response. The mind body relationship as explored by Sudnow bares witness to this (Sudnow 1978). It is possible for the sensation of playing to be driving the action. Berliner sites many examples of an improviser's material being generated as a direct result of the physical relationship with an instrument.

When leading, the body pursues physical courses shaped not only by the musical language of jazz, but by idiomatic patterns of movement associated with the playing techniques of an instrument. These, in turn, reflect the instrument's particular acoustical properties, physical layout, and performance demands. Ultimately all of these factors define the body's world of imagination, inviting it to explore their relationships. (Berliner 1994) [190]

This relationship, of course, falls within the realm of a perceptual module, where the sensation of interacting with an instrument provides data for conceptual modules but interestingly can provoke a reactive response from the performer who feels they are witnessing or experiencing the body's behaviour, rather than controlling it.

Within each instrument's general constraints, the pleasure that individuals derive from particular motions can also influence performances. "I like to play swing?" a drummer once explained while demonstrating a swing pattern for snare drum and brushes with wide, circular arm motions. "I like the way my body feels when I'm moving like this. But there are other ways I like to move too, other ways my body likes to feel. (Berliner 1994) [191]

As conceptual modules produce behaviour, which in this context becomes physically manifest, we are faced with the recursion of sensory data feeding modules that produce physical responses that in turn create sensory data. The process ruptured only by unpredictable external 'referents' and the intervention of the internal 'referents' of learnt material, motor skills, values, beliefs etc. The loop seems closed, with little room for the spark of originality or the divine inspiration that Pressing refers to as the 'seed' idea.

The generation of seeds is an associative process. That is, each new seed generated will almost always be the result of combining previously learned gestures, movement patterns or concepts in a novel relationship or context. The conservatism of this process derives largely from the limited resources of cognitive processing available for real-time composition. But all or nearly all improvisation traditions also proclaim the notion that completely new and unprecedented seed ideas sometimes spontaneously occur. The origin of such material is often ascribed to God, mysterious higher forces, or undefined transpersonal powers. (Pressing 1984) [351]

This sense of the improvisatory process not being an explainable, mechanistic activity is an important part of the belief system of many musicians. The striving for emancipation from its predictable grip and the tapping into a mode of expression which in some way transcends the monotony of the learnt and the conditioned, for some, is the imperative of the practice.

4.2 Internal Dilemmas

The questions and dilemmas faced by improvising musicians are many and some find parallel with the objections held by some artists to the validity of improvisation as an art form. During the period of the 1950's and 60's when John Cage was engaged with indeterminacy he

expressed quite an aversion to the idea of improvisation. His development of a style of composition using techniques to subvert the will or ego of the composer and/or performer was an anathema to a mode of musical endeavor that relied on an internal, totally subjective store of learnt data to stimulate its execution.

Improvisation... is something that I want to avoid. Most people who improvise slip back into their likes and dislikes and their memory, and... they don't arrive at any revelation that they are unaware of. (Turner 1990) cited in (Feisst 2002)

His objections are of course based on a sound theoretical footing. There are good reasons why it is far more difficult to circumvent this tendency in the real-time formulation and production of music than in the process of composition. We know that consciously preventing a cognitive act is impossible except by displacing one act with another but even then the initial act has to exist before it can be displaced. Berliner identifies this struggle in much of the anecdotal evidence he presents. These two examples by Bobby Rogovin and Lonnie Hillyer portray the sense of frustration experienced when the conceptual module's ability to make a novel use of stored material begins to wane.

If at some moments soloists must respond artistically to unexpected phrases arising from their vocabulary store or from their improvisations' associations, at other moments they must contend with the occasional repetitive or hackneyed use of vocabulary. "Sometimes, when you get ready to play, you say to yourself, 'I don't want to play the same stuff I always play, so you deliberately try not to play it, but you end up playing the same old stuff anyway,'" Bobby Rogovin says ruefully. (Berliner 1994) [206]

Lonnie Hillyer's experience is much the same. "Just trying to make phrases come out differently is hard at times, very hard" he says, "because we're programmed. It's almost like working against the grain at times because you want things to come out differently, and they just don't?" Improvisers may push themselves off one well-known melodic course as soon as they realize that they have started down it, only to find themselves proceeding along another familiar path. (Berliner 1994) [206]

These accounts demonstrate the inherent difficulty in consciously eliminating cognate-mechanical processes once they have gained residence in the mind. It is possible that succumbing to this pressure has a load lightening function similar to buffering in computing,

which allows a *fleeting diversion* of processing power to another goal state, which might be the formulation of the next piece of material. Berliner suggests that this type of device is used consciously by performers to 'gather their thoughts' as it were, so if it can take place within the conscious gaze there is no logical reason for it not to also take place unconsciously.

As soloists immerse themselves in their internal dialogue, the most obvious way for them to advance their conversation-responding to their "own notes" - is by pausing briefly after an initial statement, then repeating it, perhaps with minor changes such as rhythmic rephrasing. This also allows time for the player to conceive options for the subsequent phrase's formulation. (Berliner 1994) [193]

In fact, Berliner describes a situation which could be interpreted as an ebb and flow between consciously and unconsciously using this device. He suggests that the performer is 'waiting' for an event of interest but I would suggest that a more plausible explanation is that this activity represents the processing and buffering of data from the conceptual modules in preparation for its execution.

Within a performance's normal stream of events, improvisers typically allow their adequate inventions to pass by without necessarily treating their elements motivically. Rather, they await the appearance of figures that especially interest them, then explore their implications. The identification of such patterns and the treatment of their features vary with the soloists' changing sensitivities. They may hear different possibilities in, and derive new value from, the same vocabulary pattern as they perform it on different occasions. (Berliner 1994) [195]

This is a curious condition indeed, not least of all because of the performer's perceived role in this process. It seems to have little influence on the pattern of behaviour whether the performer is compliant in this operation or not, or even if they are aware of its existence. As can be seen from these last examples, there is no consensus on whether the involuntary reuse of learnt material is felt by the performer to have a wholly positive or negative impact on the performance.

Ironically, Berliner also offers a negative perspective on conceptual modules that appear to avoid regurgitation of old stock, which for some is a burden in itself. This leaves the performer to contend with the possible mismatch that might occur when the conscious mind and the motor control systems are presented outputs from conceptual modules that have no

correlation. The mind is told one thing and the fingers another. For many performers this may appear to be the 'spontaneous' act that they strive for, when in reality both sides of the mismatch are constructed from the same mix of internal and external referents that supply data to all the perceptual and conceptual modules, even the ones that are perceived to produce habitual behaviour. The performer perceives an unstable, unpredictable situation which is actually bought about by the removal of their 'feed forward' facility and the evaporation of the illusion of volition.

Under the pressures of thinking in motion and amid the rapid-fire interplay and continually shifting frames of their conceptions, improvisers routinely contend with a variety of challenging, potentially daunting, experiences. One concerns the unpredictable relationship between the musical materials they have mastered for their large store and the actual ideas that occur to them during solos. Things are always happening "spontaneously," according to Harold Ousley. He "practices certain phrases" but finds at times that "none of those phrases will come out in my solos, and I'm playing something altogether different." Or, to his surprise, patterns "come out that I've only practiced a few times and didn't think I knew well enough to play. (Berliner 1994) [205]

Perhaps this would be regarded by some as a breakdown in the fluid process of improvisation but for others this could represent a crack in the control mechanisms brought about by the pressure or real-time processing and delivery of material within the confines of a limited cognitive resource.

In the 1970s, in reviewing his opinion of improvisation, Cage adopted a pragmatic approach to breaking down established processes in the creation of improvised music. He attempted to construct an improvisational context in which the performer had no internal resource with which to make reference. John Cage, in conversation with Maureen Furman, describes his approach.

I'm finding ways to free the act of improvisation from taste and memory and likes and dislikes. If I can do that, then I will be very pleased. In the case of the plant materials, you don't know them; you're discovering them. So the instrument is unfamiliar. If you become very familiar with a piece of cactus, it very shortly disintegrates, and you have to replace it with another one that you don't know. So the whole thing remains fascinating, and free of your memory as a matter of course. (Kostelanetz 1989) [91]

Although the intention may be laudable, this is actually a very crude attempt at circumventing a cognitive process that has been evolving for thousands if not millions of years. It is the adaptive nature of processes such as these that the species has relied upon for its very survival, and it is therefore unlikely that they will be undermined by swapping a musical instrument for a cactus.

Exactly how adept these cognitive processes are at adapting to new circumstances can be seen in more of the anecdotal evidence Berliner has collected. By forging new relationships between data items and passing modules new types of parameters, it is possible for the cognitive processes that improvisation is built upon to become adaptive in the extreme.

Art Davis recalls the dramatic incident that occurred on a tour with the Max Roach quintet in which fellow band member Booker Little accidentally closed a car door on Davis's hand. During the quintet's subsequent performances, Davis's broken finger forced him to explore alternative techniques involving multiple fingers resulted in ways new to him of moving around the bass. He has continued to develop this approach over the years, evolving a technique that involves four left-hand fingers as well as those of the right hand to achieve maximum speed and agility in bass playing. (Berliner 1994) [191]

Given that such a finely tuned and resilient cognitive system is in use when an improviser performs it seems reasonable to assume that Cage's method fails to offer a practical method of liberating the performer from mechanical and habitual behaviour. His approach, however, does point the way forward for composers and improvisers who want to explore the cognitive infrastructure on which their practice is based rather than tampering with the fabric of the material that is produced. Sloboda suggests the fundamental difference between the artistic practice of composition and improvisation.

The composer rejects possible solutions until he finds one which seems to be the best for his purposes. The improviser must accept the first solution that comes to hand. In both cases the originator must have a repertoire of patterns and things to do with them that he can call up at will; but in the case of improvisation the crucial factor is the speed at which the stream of invention can be sustained, and the availability of things to do which do not overtax the available resources. In composition, fluency becomes less important; but it is much more important to keep long-term structural goals in sight, and to unify present material with what has gone before. (Sloboda 1985) [149]

If Cage's goal, to "free the act of improvisation from taste and memory and likes and dislikes", is to be achieved then tools that liberate auto-affective behaviour are likely to be conceptual rather than physical. I would question Sloboda's assertion that an improviser must accept any material that springs to mind and pay little heed to long term structure, but I would agree with the implication that improvisation can utilise tools that function concurrently with the performance providing they are not cognitively over burdensome.

Chapter 5 – Tools For Improvisation

5.1 Interacting with Tools

a toolmaker succeeds as, and only as, the users of his tool succeed with his aid. However shining the blade, however jeweled the hilt, however perfect the heft, a sword is tested only by cutting. That swordsmith is successful whose clients die of old age. (Reingold 1991) [36]

The traditional notion of a tool tends to refer to a physical artefact, used to undertake a task. This definition has been augmented in modern usage to include not only physical devices but also devices of a conceptual nature. Computers are regarded as tools but then so are the programs that run on them and the languages and components that are used to construct the programs. As our notion of tools and tool makers expands to include devices other than physical artefacts, so does the range of possible domains in which these devices might be used. An athlete may use a self hypnosis tape or a Neuro-Linguistic programming (NLP) technique to enhance their performance just as a sculptor may employ a piece of precision equipment to make fine adjustments to a piece of material.

Tools then, can be seen to exist in an ever expanding variety of domains but they can also be seen to exist in relation to the hierarchy of their use and of their construction. This hierarchy may be more clearly understood if we firstly consider that a tool's use may signify the end point in a task or process. If the task is to play a jazz standard, then a piano will allow you to undertake that task. If, on the other hand, the task is to create a rhythmic accompaniment to the Jazz standard then a drum may be considered an appropriate tool. It is of course possible to perform this task adequately with just a drum, but it may be more effectively undertaken by employing the use of a secondary tool, a beater. This would constitute what we might call a 'hierarchy of use' and raises interesting issues in regard to interface design. We have established that a drum can be operated quite successfully using a human hand but that the potential of the drum could be exploited further by the use of a beater. The interjection of another tool between the hand and the drum requires a compliant interface at each side. The physical limitations of a hand would be accommodated by a pick-axe but the pick-axe would

not interface successfully with the drum because of its weight and sharpness. On the other side, a cactus may produce an effective rhythmic accompaniment when struck against the drum but because of the needles, could not interface with the hand. Interestingly in this situation the 'hierarchy of use' could be expanded to include a glove to interface between the cactus and the hand.

The effectiveness or non-effectiveness of the interface between physical tools is likely to be more obvious than for conceptual tools, consider a foam hammer or a plug with four-pins. In the case of a physical tool the variables at play in its interface design are largely determined by physical considerations, whereas with conceptual tools, the components of the interface are likely to comprise pure data elements.

If we consider computer software under the banner 'conceptual tool' and hardware as 'physical tool' the component based architecture of computer hardware exemplifies a reasonably standardised approach to interface design. Manufacturers are free to innovate within the components they develop as long as they adopt a standardised interface. Software operates on this basis in certain domains, the development of plug-ins and virtual instruments are good examples. Computer networking has one of the most established standards, but as the component layers increase so the interfaces become less standardised and more idiosyncratic.

At each level, if the functionality of a software tool is to be fully utilised it is essential that the user of the tool, be it a human or another software component, is aware of how that functionality is mapped onto its interface. Once this is established the natural extension, of course, is for the interface to be pushed up to and beyond its limits. This endeavour is associated with human-machine rather than machine-machine interfaces and is prevalent in the use of tools of artistic expression. The way artists interact with their tools is often in a manner far removed from the modes of interaction envisaged by those that developed them. Regardless of this bastardisation or perversion of a tool's use, the mapping of its implicit

functionality to the external control of that functionality needs to be appropriately expressed in terms of the 'user' domain. This fact is reflected in the computer world by the popular saying 'for the user, the interface *is* the system'.

The reciprocal interface with the tool is, of course, the feedback mechanism. With physical tools, including traditional acoustic instruments, feedback is reasonably direct giving the user real time monitoring of the consequences of their action. In the case of conceptual tools, mediated by technology, there is the possibility of intervention in that process. This intervention could produce feedback based on the interpretation of the user's use of the tool, opening up the possibility of time lag, filtering, illusion and misinformation.

There's a fundamental difference between what we traditionally call a tool, which requires feedback to be conducted to and from the human user for operations to take place, and a device that contains its own feedback paths, that can conduct its own investigations and modify its own behaviour on the basis of what it's able to feed back to itself from the results of what it has done. (Holtzman 1994) [218]

As devices become more functionally rich the need for effective mapping between the controlling human domain and the machine's functional domain is very important if the perception of a causal relationship between the human and machine behaviour is to be experienced by the machine's operator. In a musical performance setting, this importance is elevated significantly as the resultant machine behaviour is fed back with causal effect on the performer. A consistent mismatch between intent and result in relation to the performer's behaviour will cause a significant psychological overhead for the performer. Flautist Elizabeth McNutt extols the virtue of a performer's collaboration with technology in which the terms of engagements are clearly understood by the performer.

When the terms of a piece are clearly understood by the performer, there is a corresponding increase in interpretive engagement and refinement. With live processing, for example, it is useful for a performer to understand the results of her actions on the processed sound output, so she can navigate these elements as part of her larger job of interpreting the music. (McNutt 2003) [298]

5.2 Mapping a Tools Functionality

In their work on the use of metaphor in interface design, Fels, Gadd et al assert that there are pragmatic reasons why the mapping of sound production onto physical behaviour using acoustic instruments is largely a causal and mechanical process. In many instances instrumentalists are the initiators of physical sound, they actually excite the molecules of air and their physical behaviour exerts direct influence over the production of that sound.

In the case of traditional acoustic musical instruments, physics drives the mapping between control and sound. Traditional instruments are typically implemented with mechanical systems. As such, the mapping usually is easily understood by the player. Further, the physical form factor makes learning to play the instrument possible on a reasonable human time scale. These two factors make the mapping between instrument control and sound production psychophysically transparent for the player. (Fels, Gadd et al. 2002) [110]

With instruments that mediate between the physical action and the production of sound, such as a piano or bag-pipe, there remains a tightly coupled relationship between the performer's action and the production of sound, because of the mechanistic nature of the instrument, despite the performers indirect control over the sound production.

In early electronic instruments such as the Ondes Martenot and Theremin, this tight coupling was maintained even though the technology would have afforded a less direct mapping between gesture and sound. The advent of the synthesizer saw the augmentation of the traditional keyboard with patch boards, dials and switches which allowed the performer to initiate processes rather than be confined by the temporality of the gesture. One of the earliest synthesizer developers, Donald Buchla, resisted the keyboard altogether in favour of touch plate controllers.

The art of mapping is as old as acoustic instrument design itself, but it is only since the invention of real-time electronic instruments that designers have had to explicitly build it into each instrument. (Hunt and Wanderley 2002) [106]

The introduction of computer technology into the field has now meant that it is possible to build interfaces that are active, not just reactive. In this sense they can respond to a performer

and performance environment in accordance with a predetermined parameter map, in ways that the performer may or may not be consciously aware. Many computer based interfaces continue to evolve tightly coupled gestural mapping using a variety of peripheral devices such as data gloves, motion detectors, velocity sensors etc. There are also, however, opportunities, afforded by computer based technologies, to explore the relationship between performer and sound source with the construction of responsive environments in a manner Di Scipio refers to as 'eco-systemic'. In this environment the performer and computer both exist in a relationship of 'ambient coupling', that is, the computer is responsive not purely to the performer but to the performer in the context of the performing environment.

To deal with these matters in actual compositional work, I think the agent-performer should firstly be dropped, and the DSP routines implemented in such a way as to function only based on purely acoustical information including, in particular, the ambience noise. The ambience is the real – not virtual! – space hosting the performance. (Di Scipio 2003) [272]

Di Scipio's model of a performance environment in some ways, breaks down the traditional notion of agency in an electroacoustic performance setting. His vision is not one of denying a performer agency in their relationship with technology, but mediating that agency through the performance environment. Such a performance paradigm is particularly appropriate in the context of this study as it allows for the indiscriminate mediation of agency fuelled by bio-mechanical as well as cognate-mechanical behaviour. As Di Scipio asserts, this design concept does not preclude unmediated agency but subsumes it within the greater whole, while at the same time supporting a full-duplex mode of communication between the various elements, human and non human, of the performance.

Direct man machine interactions (via control devices) are optional to an ecosystemic design, as they are replaced with a permanent indirect interrelationship mediated by the ambience. (Di Scipio 2003) [272]

Di Scipio's piece *Texture-Multiple*, for two winds, two strings, percussion, piano, and live electronics is an implementation of his eco-systemic design principle. Composed originally in 1993 this piece has been extended and augmented with each performance. The following

extract is from Christine Anderson's 2002 review of a performance by Ensemble Mosaik in Berlin.

The computer intervenes in the instrumental action through a special technique of multiple granularization with different time-scale factors. This granularization is dependent on the resonant properties of the performance space, which is tracked by a microphone placed in the middle of the room. Mr. Di Scipio calls the resulting feedback loop an "ecological system . . . in the triangle between musician, machine, and space." In his words, the composition is not so much a piece of interactive music as an attempt to "compose interaction through which music is created." The result is a highly exciting affair, not only for the audience but also for the performers. (Anderson 2002)

For the purpose of this study, the notion of eco-systemic design has been adapted and augmented in the construction of performance environments for improvising musicians. Although Di Scipio's original concept was developed as a means of exploring man – machine interaction, it is a suitable framework in which experimental work examining performers' bio-mechanical and cognate-mechanical response systems can be undertaken. The premise that conscious behaviour, whether volitional or not, has a causal relationship to environmental sensory information can be explored effectively using this architecture. There is no requirement on the part of the performer to contend with sensors, triggers or switches, merely to look, listen, feel and play. In this study Di Scipio's basic architecture will be augmented to include visual feedback, although this will only be unidirectional from computer to performer. In implementing a performance system utilising this type of architecture in which a performer interacts with a technological device, a key component of the development process is the mapping of the performer's parameter space to that of the technological device. In their exploration of techniques in this field, Hunt et al suggest the deconstruction of the mapping process into three phases or levels.

The first true stage of mapping takes these normalized data streams and extracts from them meaningful or tangible parameters... The second stage of mapping allows the connection of 'user-side' perceptual parameters to 'system-side' ones, e.g. the connection of 'sax height' to 'brightness' (where the height is clearly gathered from the performer, but brightness is a descriptive input to a synthesis process)...The final stage in the mapping process consists of transforming the 'system-side perceptual parameters' into the available inputs to the available sub-systems. For example, 'brightness' would need to undergo an interesting and non-trivial mapping process to

control the perceived brightness of a frequency modulation (FM) instrument. (Hunt and Wanderley 2002) [104]

It is interesting to note the inclusion of stage two which, if the mapping process was implemented at its most lean, could be regarded as redundant. It would be possible to map the data stream directly onto the system functionality without first filtering it through 'perceptual' space.

There are two main reasons why this stage is included in this study. Firstly, because as identified in the discussion regarding tools, it is necessary for the point at which the software components interface between the instrumentalist and the delivery system to be fully configurable. For that reason the mapping or connection points need to be expressed in easy, controllable terms that are abstract from the underlying data and low level control processes. This consideration is relevant mainly in configuring and calibrating the system prior to performance but could also come to bear in situations where real-time alteration of parameters is necessary.

The second reason relates to the performers perception of the relationship between the performer and the technological device. Goudeseune argues the case for measures that enhance a performer's understanding of how their behaviour has been mapped and qualifies this by commenting on the differing nature of mappings that can be implemented, raising issues that could determine their effectiveness.

If the performer can comprehend the mappings embedded in an instrument, obviously a more refined performance can result. This argues for static mappings over dynamic, and simple over complex (although we shall see that overly simple mappings can be sub-optimal). (Goudeseune 2002) [85]

It is precisely this concern that the inclusion of the perceptual stage in the mapping process will address. Handled effectively at the perceptual stage, complexity and dynamic mapping can be implemented in a manner non-taxing to the performer. Arfib, Couturuier et al suggest mapping as a restricting influence on the performer.

One of the roles of a mapping is to define limits, which are also boundaries within which instrumental playing or composition can exert itself. (Arfib, Couturuier et al. 2002) [141]

In contrast to this opinion, mapping could be viewed as extending performers' limits, of offering a perceptual gateway into extended functionality. The role of mapping thus becomes a means of creating an illusion of limits, providing a manageable augmentation to a performers' expressive resource.

Creating and managing the optimal relationship between a performer's limited cognitive resource and systems of immense complexity is perhaps the key to effective mapping.

Stated colloquially, reducing how many dimensions of control an instrument has makes it less frightening to a performer. More formally, such a reduction concentrates the set of all possible inputs into a more interesting set by avoiding the redundancy inherent in the exponential growth of increasing dimensionality. Even more formally, it reduces the dimensionality of the set of synthesis parameters to the dimensionality of the set of perceptual parameters: it rejects all that the performer cannot actually understand and hear, while performing. Designing an instrument around the performer's cognition/perception instead of the engineer's convenience is echoed by Jacob, Sibert, McFarlane and Mullen (1994) in the context of visual tasks: they conclude that 'choosing an input device for a task requires looking at the deeper perceptual structure of the task, the device, and the interrelationship between task and device'. (Goudeseune 2002) [94]

Managing the performer's cognitive overhead of controlling extended functionality is, therefore, an important function of the interface map. To this end, there needs to be an appreciation of the mapping that already exists if a performer's primary tool is a traditional/acoustic instrument.

Both player and listener understand device mappings of common acoustic instruments, such as the violin. This understanding allows both participants to make a clear cognitive link between the player's control effort and the sound produced, facilitating the expressivity of the performance. (Fels, Gadd et al. 2002) [110]

The communication of this mapping to an audience, as a model of expression, is not within the boundary of this study as a discrete area of exploration. It is relevant however, in so far as it has a causal effect on the performance environment, in which the audience has an obvious influence. As Hunt et al suggest, it makes sense to endeavour to harness and build on the complex mapping that already exists in traditional instrumental music making. That is not to

say that the construction of new expressive tools with unfamiliar interfaces does not hold its own virtue, but that in performance paradigms, where there is an imperative to restrict the cognitive burden of interfacing with technology, this is an effective way to proceed.

The saxophonist had built up almost two decades of performance subtlety on his instrument, and so it was felt that much of the complex acoustic mapping was inherently present in his existing performer-instrument system. The main task was therefore to convert the instrument's sound, and the player's performance gestures, into new sounds and graphical control. Note how different the situation would be if the player were using a novel electronic sax-like controller, and the entire sound synthesis system had to be defined and mapped. (Hunt and Wanderley 2002) [104]

In using a traditional instrument as the controlling device in a computer interface, what is being constructed is a two tiered mapping system. This multi-level control system sees primary control of the computer system being mediated through the environment to a secondary control, which is the musician's instrument. What Goudeseune offers in his analysis of the use of secondary controllers is the potential to handle the complexity of the primary control system by building multi-functioning into the secondary controls.

Introducing secondary controls reduces the number of primary controls, thereby simplifying the controller. Of course this is a compromise: 'simultaneous' adjustment of multiple controls is reduced. Also, the interface is deepened even while it is parroted: the performer's mental model of the instrument is more elaborate and takes longer to learn. A range of compromise in fact exists. At one extreme there are k primary controls (strings on a stringed instrument, keys on a multiple touch-sensitive clavier) and no secondary controls, at the other extreme one primary control with a single k -way selector switch (e.g. the Ondes Martenot). Between these two extremes there may be primary controls with an n -way selector switch, where $nm \geq k$ (bass guitar: $m = 4$ strings, $n = 3$ -way pickup switch). If only a few secondary controls extend the interface of an orchestral instrument, they can often be operated by the feet, for instance as a bank of toggle switches or a three- or four-way 'gas pedal'. (Goudeseune 2002) [88]

The use of a traditional instrument as the secondary control device addresses other issues raised when interfacing musicians with digital technology. Wessel et al, in the construction of their conceptual framework for gestural mapping in musical performance, allude to the limitations of a system based on the direct mapping of human control data onto the software parameter space. They suggest that for volitional control of the software, as manifest in the performer's 'intent', the model they have adopted operates effectively, but for situations in which experimental rather than predictable behaviour is likely to be exhibited by the

performer the model is likely to be less successful. This might suggest the suitability of directly mapped interfaces for composed music, in which the performance processes are fairly tightly defined with little room for variance on the whim of the performer, as opposed to performance processes in which the performer is encouraged to venture into unknown territory.

One aspect that is not well captured is the way in which performers' intentions are elaborated upon by discovery of new possibilities afforded by the instrument. Experimental and otherwise exploratory intentions are certainly dear to the authors. We find that this albeit schematic framework allows us to view the roles of human motor learning, controller mapping, and generative software as an overall adaptive system. (Wessel and Wright) [1]

It is significant that McNutt, who uses an acoustic instrument as her primary tool to interface with electronic systems, relishes the prospect of more control over the material in a performance situation. This desire may or may not exist because of the facility she already possesses to control the secondary device, but it certainly suggests an aspiration from the acoustic end of an electroacoustic collaboration for the ability to influence and to stretch the fabric of the performance.

Giving the performer control over the flow of time is crucial; control over dynamics and timbres is also valuable. Some composers have even created works that give the performer real-time influence over the actual form and materials of the piece. Electroacoustic music that invites these kinds of creative collaboration presents vastly more satisfying models of chamber music than fixed accompaniment. (McNutt 2003) [300]

It would be conjecture to suggest that presenting extended functionality through a familiar interface is more likely to provoke more extreme or radical use of that functionality than its access through a bespoke, direct interface. However, on a purely mechanical level it would seem reasonable to suggest that the cognitive overhead of contending with extended functionality via a controlling device with which there is limited familiarity would impede the extent to which experimentation could take place.

5.3 Prosthetic Mental Functioning

From the performer's point of view, a composer's use of electronics will always involve some prosthetic elements that complicate the practice of her art. These can

stand in the way of the ideal collaboration between composers and performers.
(McNutt 2003) [298]

McNutt's view of technology as prosthetic is an interesting one. It is interesting on many levels not least of all because she locates the use of the technology, not with herself but with the composer. This is an intriguing distinction to make in the light of her obvious involvement with the development and use of those systems, and it serves to highlight the diversity that can exist in the relationship between a tool and its user. It is interesting also, that from this perspective, the notion of a 'prosthetic element' is presented as impedance to her practice, and as a performer of composed music using technology, I am sure she is not alone.

This contrasts with the general notion of prosthetics as a positive appendage, giving access to extended functionality and additional facility. It is this 'general' interpretation of the term, which I would suggest, might be more appropriately applied in such a situation, if the performer was engaged with improvised rather than composed performance. In fact it is within the arena of improvised electroacoustic music that the notion of prosthetics could be expanded to include not just physical tools but conceptual tools also. There is a sense in which all physical tools could be regarded as prosthetic; Heidegger's hammer acts as an artificial extension to the arm offering greater leverage, more resistant material and increased impact with musical instruments operating in much the same way. Why then should a pocket calculator not be viewed in a similar vein? Conceptual tools offer an artificial extension to an existing facility and in that sense offer prosthetic mental functioning. This concept is not new and was developed, albeit using different nomenclature, by one of the pioneers of virtual reality, Fredrick Brooks, in the 1970's. Brooks believed in the use of technology to augment human potential rather than for its mimetic qualities. Howard Reingold recalls a conversation with Brooks at North Carolina University.

I believe the use of computer systems for intelligence amplification is much more powerful today, and will be at any given point in the future, than the use of computers for artificial intelligence (AI). In the AI community, the objective is to replace the human mind by the machine and its program and its data base. In the IA community,

the objective is to build systems that amplify the human mind by providing it with computer-based auxiliaries that do the things the mind has trouble doing. (Reingold 1991) [36]

This philosophy seems to permeate the field of virtual reality, particularly amongst the leading lights in the early days of its existence. In expressing her personal philosophy towards performing with technology, McNutt conveys similar sentiments to the pioneers of virtual reality. Her desire to have her potential for human expression stretched and expanded in ways that autonomous performance would not allow seems to endorse the ethos prevalent in the field of virtual reality.

I personally prefer the musical opportunities provided by interactive systems, and hope that composers will continue to explore these directions. I relish working with interactive partners that open new musical territory no human could provide. I want the machine to respond to me and challenge me in ways I could not have imagined, and to nourish my creative expression in performance. (McNutt 2003) [303]

In contrast to the 'artificial' in artificial intelligence, which seeks to autonomously learn from, emulate and extrapolate human potential, the 'artificial' in prosthetics is a linkage between human centered processes and functionality that normally exists beyond reach. It is significant that McNutt in one instance refers to the '*complication*' of her practice in regard to composers' use of technology, while describing a dialogic situation with technology as being '*nourishing*'. She is perhaps articulating the feeling of technology as 'other' in the former and as 'extended self' in the later. She cites the composer Cort Lippe's opinion as an endorsement of her own.

I firmly believe that empowering performers with the ability to exercise control over an electronic part, based on a performer's musical expressiveness, is an important factor in computer music's future. (McNutt 2003) [300]

The significance of this increased awareness of the needs of performers, as well as composers, in the development of technological tools is compounded when composer and performer are one, as can be the case in improvisation.

The empowerment to which Cort Lippe refers relates to performers who may or may not have limited influence on the material being played, but whose function is primarily to 'follow

instructions'. In a situation when a performer is creating and following their own instructions there is the potential to introduce prosthetic tools into each of these activities. It is of course a non-trivial task to view these processes distinctly because of the tightly coupled nature of their execution. It would also be a very burdensome undertaking for a performer to have to deal with a duality of prosthetic tools in real-time under performance conditions.

The notion of mapping becoming transparent (Fels et al) describes a situation when the performer can comfortably cope with the cognitive load of the controlling device.

As an example, the acoustic guitar is a well known instrument. The lay audience understands the manner in which the player's control gestures map to sound outputs even if they lack the physical proficiency to play the guitar themselves. This common understanding makes the guitar's mapping transparent to the audience. With enough practice, it also becomes transparent to the player. Under these (common) conditions, the guitar is an expressive instrument. (Fels, Gadd et al. 2002) [110]

Here a situation is described where a prosthetic device is used to deliver the musical material and where the 'transparency' of the interface enhances expression. It doesn't however, address the formulation of the material prior to its execution.

In the delivery of composed music, an appropriately designed physical tool is all that is required, unless no tool is needed. In improvised musical performance the situation is often the same. However, there is the potential to include a conceptual tool if required, such as chord sequences, graphic scores, etc. As Brooks implies, the key to developing conceptual tools that are liberating and carry a realistic overhead is to interface with innate human processes. To this end he defines three areas of potential in which the human mind is more powerful than any computer system likely to be developed in the foreseeable future. The three areas being pattern matching, evaluation and contextual recall. It is perhaps significant that these three areas have particular significance in the model of man-machine interaction that has been developed for the purpose of this study, to represent the paradigm of musical improvisation performance. Although Brooks describes his three areas in terms of discreet functioning, as a combinatorial system he has identified precisely the processes that interact in order to stimulate the manifestation of human behaviour. The example that Brooks gives

of "the pattern recognition power a one-week-old baby uses to recognize its mother's face from an angle and with a lighting it has never seen before." (Reingold 1991) [37] serves to illustrate two fundamental tenets of the model of the improvisation performance paradigm under examination. Firstly, that the magnitude and potential of the processing power that exists within the human domain dwarfs that of the computer domain, and secondly that the vast majority of this power lies outside the realm of consciousness. This underpins the notion that technology could usefully be harnessed, not to emulate human cognition, but to augment it by providing tools to release its potential.

Brooks believes, it is possible to multiply that power by using the computer to show humans patterns in ways they are not normally able to perceive, and let the human side of the system decide which ones are meaningful. (Reingold 1991) [37]

The supposition that the majority of cognitive processing power lies outside the conscious realm leads one to contemplate the potential of conceptual tools that also exist in this domain. It would be expeditious to remember at this point that a subconscious overhead is still an overhead. Just because someone is unaware that cerebral work is being done doesn't diminish its drain on the overall cognitive resource. What is perhaps the most intriguing aspect of this contemplation is how such a tool could manifest itself. It seems perverse at first to envisage a tool that cannot be perceived by it's user but consider, on the one hand, the 'transparent guitar' that Fels et al evoke and, on the other, cognitive tools such as meditation and hypnotherapy that exert their influence in the sub-conscious domain. It's reasonable to question the validity of regarding something so ephemeral as a tool yet there are tangible benefits in their use.

In many respects there is a commonality between such cognitive tools and a particular type of software application known as a TSR (Terminate and Stay Ready). Such programmes are executed but lie dormant until a pre-defined trigger spurs them into action, the post-hypnotic suggestion probably being the nearest cognitive equivalent. Situations when anger management or assertiveness training techniques are instinctively evoked might be regarded

as behaviour that occurs as a result of a tool which lies dormant in the subconscious until a pattern match for it's use occurs.

It is worth, at this stage, returning to the technique pioneered by Milton Erickson for the delivery of hypnotic suggestion, the use of metaphor. Metaphor could be regarded as a second level of indirection or representation. A phenomena that exists within the confines of a symbolic language but which is itself symbolic.

In one sense metaphors are symbols created from symbols, where direct representation becomes implied as it is mediated through a meta-language. Metaphor is an important instrument in the perceptual mapping of a physical tool's functionality as well as providing a conceptual tool to exploit functionality that exists in the realm of the subconscious. Using familiar metaphors for physical tools reduces the cognitive burden of learning and operating them and can, as Fels et al identify, provide a consistent mode of interaction.

Metaphor can also be used as a design tool when creating new instruments. If a new synthesis engine is implemented, suggest a metaphor that encompasses its main characteristics. The metaphor may then dictate an appropriate controller for the device, so that the entire device is self-consistent. (Fels, Gadd et al. 2002) [114]

This is not to say that metaphor cannot be used as a means of subverting accepted forms of representation. The example of the musical keyboard serves to illustrate both sides of metaphorical representation. The musical keyboard has served as a metaphor in instrument design, long after its purpose as an interface onto a mechanical instrument has been surpassed. As an interface onto modern synthesisers it has a metaphorical function providing a mechanism for skill transference and speedy access to electronic functionality. Contrast this pragmatic use with the deconstruction of the keyboard metaphor for artistic purposes.

In the case of the piano, a range of finger positions is understood to activate a single key. This metaphor has been used in instruments that use a key model but do not have explicit keyboards, such as in the Virtual Piano created by Leonella Taraballa and Graziano Bertini at the CNUCE in Pisa in 1997. The Virtual Piano removes the keyboard entirely, relying on the familiar gestures of a pianist without the physical keys. (Fels, Gadd et al. 2002) [112]

Therefore, metaphor is as equally effective in ironically subverting accepted modes of representation as it is in enforcing them. This may also be a useful way of viewing human behaviour stimulated by metaphor. Perhaps the subversion of an accepted mode of representation in cognitive terms is a metaphor that produces 'dysfunctional' behaviour. This negative manifestation could be the result of a metaphor having an inappropriate underlying representation, phobias being a prime example. Perhaps someone might exhibit a response to seeing a spider that would more appropriately be displayed on seeing a tiger, and so in a sense the spider becomes a metaphorical tiger. The reason this is interesting in the context of this study is that improvising musicians are as likely to hold a metaphorical representation of the activity they are engaged in as people in any other walk of life.

In jazz metaphor is rife, the 'bridge', the 'turn around', the 'head', 'swapping phrases' and 'cooking' to name but a few. Subverting metaphors that exist conceptually is a hugely more challenging endeavor than overriding accepted modes of representation in the physical domain. As previously discussed (chapter 2), consciously attempting not to think about something is doomed to failure. There are, however, exciting possibilities for harnessing the power of metaphor in the development of new conceptual tools that allow the remapping of responsive behaviour with the use of hypnotic scripts. In using such a technique to deliver information pertaining to the performance environment, the performer requires less cognitive resource for the *modus operandi* and so frees up resources for the fabric of the performance. Another important aspect of a conceptual tool such as this, is the influence it can bring to bear on the balance of bio-mechanical and cognate-mechanical behaviour. A conceptual tool that resides in the sub-conscious domain can exhort a certain amount of control over the level of conscious engagement the performer has with the material being delivered during performance, and in the case of this study with the *relationship* that exists with the technology.

5.4 The Performer's Perception

The development work undertaken as part of this study will be described in the next chapter. However, it is worth taking a few moments to discuss the aspects of the design which one could perhaps regard as representing a paradigm shift in performance environments.

Di Scipio offers a summary account of interactive performance systems which broadly covers the field in which the practical work for this study might be situated.

Notwithstanding the sheer variety of devices and computer protocols currently available, most interactive music systems – including developments over the Internet – share a basic design, namely a linear communication flow: information supplied by an agent is sent to and processed by some computer algorithms, and that determines the output. This design implicitly assumes a recursive element, namely a loop between the output sound and agent-performer: the agent determines the computer's changes of internal state, and the latter, as heard by the agent, may affect his or her next action (which in turn may affect the computer internal state in some way, etc. (Di Scipio 2003)[270])

The significant aspect of Di Scipio's observation is the identification of recursion as the mechanism that drives the interaction between the performer and the technological tool. In general terms this seems to be a fair reflection of both electronic and electroacoustic performance architectures, in as much as the performer's agency is controlled by the technology's output, which is caused by the performer's agency.

The main system designed for this study represents a departure from this architecture in two respects. Firstly the eco-systemic principles that have influenced the design of the interface onto the technology mean that the recursion Di Scipio describes is compromised by the inclusion of environmental data into the feedback loop.

The second and possibly more fundamental point of departure is the nature of 'agency' on the part of the performer. The inclusion of a conceptual tool into the system architecture removes the notion of the performer as conscious controller. It is probably this aspect of the performance environment that is the most radical in terms of the challenge it presents to accepted notions of agency and volition in improvised musical performance. This rich seam

of enquiry seems to be supported by Debono's vision of how perception and cognition are fertile areas of exploration for the arts.

As a matter of fact, perception is more than simple sensing, and cognition is not solely driven by internal or representational activities. They are both taking the same pathway to translate a singular description of the world. This means that human thoughts and emotions not only participate in an aesthetic universal ability but also play equal parts in creation. Sensory access to matter has as great a significance for an artist as for a scientist. But the dialectics between the objective and the subjective part of an object being observed are not identical. As an illustration, the dynamic interrelation of cognition and art is now a new way to investigate levels of perception or reality and will probably bring to light new epistemological fields. (Debono 2004) [247]

Marc Couroux is a composer and improviser dealing with psychological performance states which could perhaps be regarded as meta-musical and offers an interesting analysis of the contemporary music performance paradigm from the perspective of his own practice. Although Couroux's critique of contemporary musical performance practice is centred around the composer – performer – audience relationship, his observations in regard to the expansion of the performance paradigm beyond the construction of virtuosic performances is very pertinent to this project. Perhaps we see in Couroux's performative 'sea at large' a reflection of Di Scipio's 'ecosystemic' approach to performance system design.

In Evryali, the notion of "failure" doesn't come into play in as much as the performer is always required to engage the larger sonic picture adequately enough so as to give the "impression" that everything in the score is being played. Evryali becomes a largely personal conflict, a struggle with oneself to 'jest a successful image to an audience (the Olympian bravura is still omnipresent), despite the overwhelming odds. But the roots of a new performative paradigm lie there, in "The sea at large," one of the most fruitful areas to explore in instrumental music, though largely unexplored since. (Couroux 2002) [57]

What Couroux succeeds in achieving is the re-framing of basic assumptions about performance practice, assumptions that underpin the notion of performance validity and of performers' integrity.

I would suggest that it is in this spirit of reformation that this study attempts to expose the verisimilitude of other facets of the accepted nature of musical performance with particular reference to improvisation. Couroux's challenge on the notion of virtuosity and the

imperative of accurate reproduction in the performance of composed music could be viewed as comparable with notions of control and volition in improvised performance. The time is perhaps ripe for the expansion of the traditional performance parameter space to include such areas that are so often shielded by convention. As Debono suggests, these are the domains where fields of enquiry become blurred, where artist and scientist draw closer together in their desire to explore human perceptions of reality.

Precisely in this pre-conscious sphere could be the point where the arts can help science to get beyond itself. (Debono 2004) [247]

In some ways the ideas of both Debono and Couroux allude to artistic practice that raise questions not just about how humans behave but about how humans think they behave.

Debono acknowledges the evolving relationship that exists between art and cognition even in the work of artists who may not be conscious of its existence.

It is likely that few artists are directly aware of these findings, but most of them are nevertheless working in this same direction: the understanding of human reality. When we see Rodin's sculptures, they refer to human experience as much as to the aesthetic concept of beauty or purity. (Debono 2004) [247]

Another example of this evolving relationship can be seen in the work on left/right brain interfaces by Garvey. His work raises interesting issues in relation to the style of visual interfaces adopted in this study. The interface developed by Garvey is concerned primarily with delivering visual information, in the form of two simultaneous video streams, to the left and right hemispheres of the brain. The implications for this project are in the area of cognitive capacity and the brain's strategies for processing multiple streams of visual information. Although this work is primarily concerned with visual perception, the basic premise of working within and experimenting with a finite cognitive resource is also central to this study.

Coherence and integration are closely related to capacity limitations. We are unable to keep in mind more than a few objects at a time. The psychological refractory period, which is approximately 100-150 milliseconds, limits how fast we can make a discrimination choice. Attempting to do two things at the same time is difficult, because one action interferes with the other. Edelman and Tononi conclude that "the

limited capacity and serial succession of conscious states constitute the price that is paid for their integration - for the fact that they are reducible to a simple sum of independent components. (Garvey 2002) [321]

Although not explicitly mentioned by Garvey, the psychological concept of chunking, described in relation to musical improvisation in chapter 2, is one that is central to the cognitive processes stimulated by his interface. Garvey's work in visual perception is framed in the context of how a viewer might perceive a narrative that was presented to them bilaterally.

The consumer of an art work is perhaps the most obvious focus in an art production system for the exploration of cognitive processes. Within the context of *this* study, this is not the case. The approach to the overall design of the performance environment for this study embraces the notion that the performer, as system component, is as open to psychological influence as any other human component, including the audience. There is an intriguing twist in this scenario in that the audience can observe the subliminal affect on the performer as well as being affected themselves. This further reflects the eco-systemic nature of the performance environment.

On a closer look, the role of the agent-performer appears itself ambivalent (no criticism implied), in that it is the only signifier of the system's external conditions and, at the same time, it represents an internal component of the overall meta-system including man, machine and environment. (Di Scipio 2003) [270]

5.5 Unilateral and Bilateral Brain Processing

The effect of right and left brain processing on the creation of art as opposed to the consumption or perception of art has been explored extensively by Betty Edwards in the development of conceptual tools to improve people's ability to draw. The theoretical principles that underpin her work were first developed by the Nobel Prize winning psychobiologist Rodger W. Sperry. He undertook research into brain-hemisphere functions in 1968.

His stunning findings, that the human brain uses two fundamentally different ways of thinking, one verbal, analytic, and sequential and one visual, perceptual, and simultaneous, seemed to cast light on my questions about drawing. The idea that one

is shifting to a different-from-usual way of thinking/seeing fitted my own experience of drawing and illuminated my observation of my students. Edwards [xii]

The conceptual tools developed by Edwards gives the artist a process by which they can move cerebral processing from the left to the right hemisphere of the brain. The effect of achieving this is to avoid the creation of symbolic representations of visual information. This allows the artist to draw what they see from primitive visual information rather than pre-constructed units. The side-effects of this process are similar to those of a hypnotic trance. Edwards describes her students experiencing an unawareness of the passing of time and if voices were present, being able to perceive their sound but not their meaning.

The method that Edwards uses to achieve this effect is to present the brain with a task which is more suited to the right hemisphere than the left. In this situation what seems to occur, is an initial attempt by the left hemisphere to cope with the task, followed by a period of decreased activity on the left and an increase on the right. This is induced by giving the artists tasks in which they are required to look at their subject in a manner which prevents them recognising the component parts as objects.

It seems that when the left hemisphere cannot offer symbolic interpretation of the information it is presented with, it hands it over to the right hemisphere for processing. In visual art this technique has proved to be very effective, and once mastered, can be utilised in a range of situations.

Invoking 'visual disorientation' as a means of pacifying the left hemisphere is obviously more suited to visual rather than non-visual tasks. It is interesting that disorientation is a common method used to induce a hypnotic trance. Momentarily jumbling words into a meaningless order within a hypnotic script seems to have much the same effect as Edwards' technique. The problem that the method of visual disorientation presents in a musical context is that symbolic representations of music are largely restricted to music notations.

There is perhaps potential to exploit these ideas in composed music, read from a score, but it is the act of playing in improvised music where the art is cited, not the act of writing, because creation and delivery in improvised music exist in real time. The process and the artefact in visual art and composed music are in many cases discreet and in the cases where they are not, this technique would perhaps not be appropriate. In order that the underlying principles of these techniques can be utilised in the development of a conceptual tool for improvising musicians, another approach to inducing the left/right switch needs to be developed.

There is a certain amount of anecdotal evidence to suggest that, as opposed to Edwards' approach of defeating the left hemisphere with an impossible task, there may be a case for merely occupying it with an unrelated task. Stan Tracey has for more than six decades been a hugely influential pianist in British jazz and is also revered for his compositions.

I write far better stuff and more logical, watching television. I can watch a television program and I'll drift off the program in my mind onto the music that I've been writing. Because I'm not concentrating so hard on doing it ideas come easier. A lot of the stuff I've written has be done while I've been watching television, it really works. (Tracy 2004)

Tracey seems to have intuitively found a technique which lubricates the flow of ideas, based not on the suppression of activity in his left hemisphere but stimulating it with an activity which is completely unrelated to the task in hand. It seems that for Tracey, giving the left hemisphere something to do prevents it from stifling creative processes in the right hemisphere. It would be interesting to know what types of television programs were more or less successful in the use of this technique, although it is perhaps reasonable to assume that an element of dialogue would have been involved, given the left hemisphere's propensity to decode language.

This would seem to be a reasonable assumption on two counts. Firstly, it is unlikely that in the prolonged use of this techniques Tracey would be able to avoid listening to dialogue, and secondly, because it could offer an explanation of why the technique is so successful for him.

Robert Zatorre has undertaken an extensive examination of the auditory cortical regions of the brain using brain imaging techniques to monitor brain activity under a range of conditions. He has observed significant differences in the manner in which the left and right hemispheres process auditory information.

With respect to speech processing, a vast body of data indicates that certain aspects of speech decoding depend critically on left auditory cortical regions. Current evidence suggests that there are functional hierarchies, such that early stages of processing depend on core areas bilaterally with 'higher' word-recognition mechanisms being associated with more anterior and ventral auditory regions in the left hemisphere. Zatorre [39]

Zatorre has identified a general level of auditory perception which provokes brain activity in both hemispheres prior to any interpretation of the sound. On the recognition of the sound as speech, processing shifts to the left hemisphere. This may go some way to explain why when listening to a speech signal and a non-speech signal, the speech can be decoded reasonably easily, whereas simultaneously decoding two speech channels is problematic. Both situations involve the perception and decoding of two discreet signals but the former example is parallel-processed by the left and right hemispheres.

Interestingly, a similar scenario cannot be applied to the right hemisphere. The process of perceiving and decoding speech sounds is a resource hungry activity because of the speed at which temporal and tonal information has to be decoded. The right hemisphere seems to be optimized for slower sound events and consequently can simultaneously handle more of them. Charles Ives, in an extreme example of this phenomena, composed a piece of music called Three Pieces in New England, in which he simulates two marching bands simultaneously playing different pieces of music. Although regarded by some, from an aesthetic point of view, as cacophonous, it is possible for the audience to decode the different streams of musical information in real-time and to further distinctly perceive the timbres of the instruments involved. This would almost certainly be a right hemisphere function.

Thus, the predominant role of the left hemisphere in many complex linguistic functions might have arisen from a slight initial advantage in decoding speech sounds. The important role of the right hemisphere in aspects of musical perception –

particularly those involving tonal pitch processing – might then have been in some sense a consequence of, and is complimentary to, this specialization of language. Zatorre [44]

5.6 Modes of Interference

It seems appropriate at this point to posture a plausible framework for the development of a cognitive tool for use by an improvising musician. A tool that can be assimilated into the design of a performance architecture broadly based on the eco-systemic principles discussed earlier.

The overall framework centres on a single improvising musician using a conventional musical instrument. The environment also has within it a computer based system which produces audio visual output. The key to understanding the type of performances that might emanate from this environment is in the way information is mapped between the various components. The term ‘various components’ is used here to reinforce the notion that from an ‘eco-systemic’ viewpoint, the performance environment comprises more than just the performative components; audience,

physical environment, acoustic properties etc. are all influential.

The mapping of information between components of the environment is configurable at two points within this particular interpretation of the performance parameter space, those points being at the gateway into the computer and the performer (Figure 5.1).

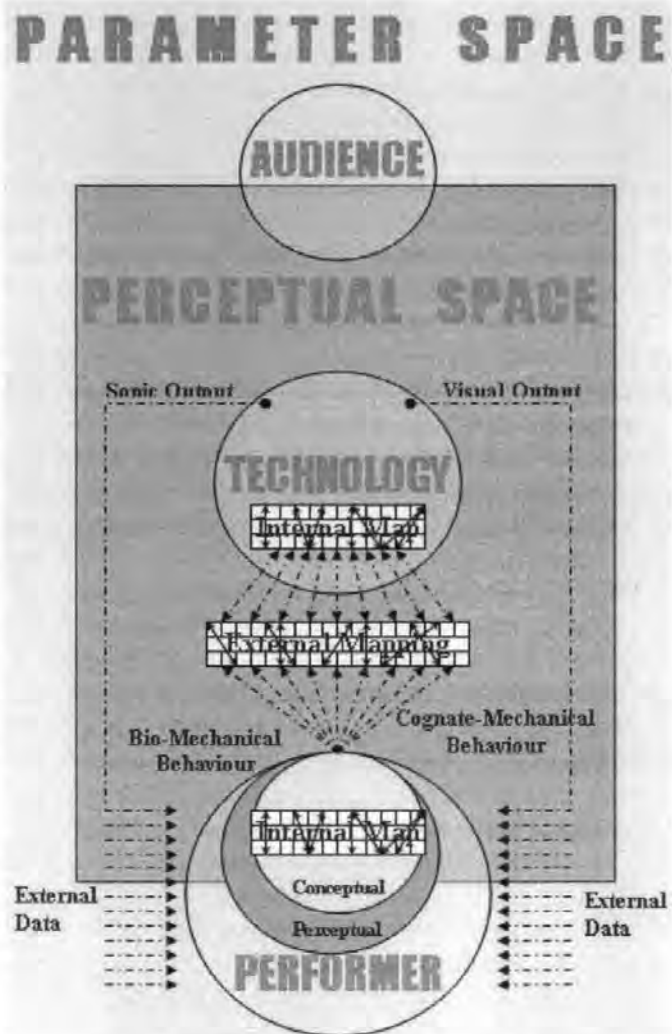


Figure 5.1 Performance Parameter Space

The mapping of environmental data onto the behaviour of the computer takes the form of a parameterised software component that is, in normal circumstances, configured before the commencement of the performance. This has been developed using the eco-systemic principles discussed in the previous sections of this chapter. The reality of this is that the only live data input into the computer is the acoustic activity in the performance space, which is of course primarily but not exclusively produced by the performer. This acoustic information is then mapped onto the software component via a configuration interface where the various parameters that govern the component's behaviour can be set. Although the computer will respond sonically and visually to the information it receives, it is important to understand that although the performer can affect the behaviour of the computer, the relationship between action and response is not likely to be explicit. The software has the capacity to make 'autonomous' decisions and can also vary its behaviour over the course of the performance.

The second configuration point within the architecture is the mapping of environmental data onto the performer's behaviour, which takes the form of a hypnotic script, and is also delivered prior to the performance. It is significant that equivalent nomenclature has been employed in this study to describe the way both the performer and computer interface with external data. This is because a 'systems' approach to the development of both these tools has been taken, even though in general usage the term system is applied much more readily to a computer than to a human being.

It is interesting that we routinely regard physical processes as systems, nervous, digestive, limbic, endocrine, immune etc., but rarely processes involving emotion or mental functioning. We don't tend to regard crying, speaking or memory as a system. The approach taken in this study to the construction of a conceptual tool with which to address the cognitive limitations of an improvising musician bears similarity to the systemic approach to hypnotherapy devised by Dylan Morgan.

The pattern is clear. The Hypnotherapist is reducing the activity of nearly all systems one by one. Higher-order faculties which are harder to observe, such as an internal verbal analysis of what is going on and a critical analysis of its content, are typically also reduced. There is, however, at least one exception to the general rule that systems are inactivated: and that is the aural system. The Subject must continue to be able to hear the Hypnotherapist. Ideally this system should become *more active* than usual: the intention is for the listener to respond more than usual to what is said by the Hypnotherapist. This may be accompanied by a reduction of attention to other sounds. Another possible exception will be a particular other system that the Hypnotist is aiming to change: it may well be that the goal is to enhance its activity. The Hypnotherapist may, for example, be aiming to *enhance* a memory or to *activate* the imagination. (Morgan 1996)

In this study the architecture of the main system prototype exists on various conceptual levels, ranging from the abstract and theoretical aspect of its design, through its system level design, to the performance level design and finally the realisation of a performance. The discussion so far has centred on the abstract and theoretical considerations of its design. The following chapter will elucidate the evolution of my practical work, beginning with the definition of an analytical framework with which to view the various systems. This forms a chronology of early developments together with events and encounters that influenced the main system's design. The software prototype which has been produced can be implemented in different ways, using different parameters to create very different performance environments, that is to say, the realisations documented in this study are in a sense exemplars.

Chapter 6 – Evolution Of The System

The research I have undertaken in the completion of this study has had a profound influence on my practice as an improvising musician and interface designer. If I look back over the work that I have completed during this period I can trace the evolution of thoughts and ideas that have grown and developed with each addition to my portfolio. With the benefit of hindsight it is now possible to abstract trends and characteristics from these works which reflect themes in my thesis.

All the works described in this chapter are documented on the CD Rom (Appendix 1). The disk contains some systems diagrams, screen captures, performance documentation and video footage where available. The works contained on the disk are as follows:

1. Musaïc - Interface for solo performer
2. Lost Hour - Installation
3. Scribbler - Durational audio visual system
4. Hexagram - Interface for improvising ensemble
5. FreeKey - Interface for solo improvising performer
6. Milieu - "Moving The Traffic and The Sun" for solo performer

Before looking at the various works in detail it is worth looking at some general characteristics in order to construct a simple analytical framework which can be applied to the individual works.

6.1 Generic Characteristics

I have grouped together relevant characteristics into four broad classifications. The first relates to audio visual content and describes the type of material the system outputs to the performance environment. The second is related to performer feedback and response. This section classifies the performer's perception of the feedback delivered by the system and the types of response it is likely to provoke. The third section classifies the ways in which the system can respond to the performer. At first glance this may seem indistinguishable from feedback, but it must be appreciated that the system may respond to the performer in ways that are not fed back. In that sense the response repertoire of a system may be far broader

than mere feedback. Last is the performer's goal state which classifies ways in which a work may manipulate or influence a performer's goal state during performance.

If there is a theme that runs through these classification systems it is that many of the areas employ classification systems based on whether the performer is conscious of some aspect of the work or not.

6.1.1 Audio Visual Content

It is important to classify the audio visual content in terms of its position on the continuum between static (fixed) and dynamic (generative) as this fundamentally affects its relationship with the performer. In terms of assessing the level of 'fixedness', the approach I have taken is to consider the audio visual content in terms of its form (structure of the piece) and content. I have classified this aspect in relation to the work's responsiveness to the performer. That is to say; if the content is fixed regardless of the performer, if it is variable but changing in a fixed relationship with the performer, or if the content is variable and changing independently of the performer etc.

Figure 6.1 Audio Visual Content

CONTENT	Autonomous	Responsive	FORM	Autonomous	Responsive
Fixed		✓	Fixed		
Generative			Generative	✓	
Mixed			Mixed		

Fig 6.1 would represent a work in which content is delivered in response to the behaviour of the performers but whose response mapping was fixed for the duration of the piece. However, the form of the piece would be dynamically generated but would not be responsive to the behaviour of the performer.

6.1.2 Performer Feedback And Response

In referring to feedback I am considering the communication channel that feeds back information to the performer in response to their behaviour. If both audio and visual channels are used the consequences of the performer's behaviour will be fed back to them using both

channels simultaneously. However, the performer's behaviour may be mapped differently on each channel. How the performer interprets the feedback is dependent on their goal state and how they respond is dependent on their behavioural map. This process will be influenced by the performer's cognitive load because their responsiveness to feedback may be diminished if the mode of interaction is too burdensome.

I have classified the performer's response to feedback in two broad categories, reactive and predictive. If the performer's response is reactive they are more likely to exhibit 'bio-mechanical' behaviour. If it is predictive their behaviour is likely to be 'cognate-mechanical'. The former is manifest in behaviour that is in response to audio visual events. The latter is resultant on an extrapolation of events in order to produce a response appropriate to the prediction of an event. This type of response is based on a forecast drawn from previous and current experience. An example of the first type of response in improvised ensemble playing might be if one player plays a loud high note and another player reacts by playing a similar gesture. An example of the second type might be if a player becomes aware of a gestural movement by another player and successfully synchronises a response to coincide with the climax of the gesture.

Figure 6.2 Feedback and Response

	Reactive	Predictive
Audio	✓	
Visual		✓

The example in figure 6.2 would represent a situation where a performer would have to react spontaneously to the work's audio output but was able to foresee the trajectory of the visual output and react accordingly.

6.1.3 System Response

Some of the works in the portfolio are responsive to their environment. These works vary significantly in the manner in which they respond. Two aspects against which a response can be categorised are its stimulus and its retort. For the majority of the responsive works the

stimulus is sound. The sound is captured and using Fourier analysis the frequency bins are mapped to parameters in the system. It is the mapping that determines the retort and can be categorised as unified or distributed, static or dynamic. Unified mapping indicates that there is a single set of responses that can be mapped to the incoming data, so in other words, the work will make one response at a time. A distributed mapping implies that the work may distribute the incoming data to a number of processes and so respond in a number of ways simultaneously. The static nature of the mapping implies that it is fixed for the duration of the performance. If the facility exists to change the mapping during the performance either by self organisation or human intervention then the mapping is classified as dynamic.

Figure 6.3 System Response

	Static	Dynamic
Unified		✓
Distributed		

In fig 6.3 a work that had this system response classification would produce a set of responses in series but may not consistently respond in the same way to the same stimulus.

6.1.4 Performer Goal State

This refers to the goal state of the performer during engagement with the interface, i.e. the performance. It has been identified in the previous chapters that goal states in everyday life are often nested, except, for example, in life threatening situations. This means that at any time an existing goal state can be interrupted by the requirement to service a goal state of a higher priority. The goal states that are implicit within each of the works in this portfolio differ significantly. Nesting is not the whole picture; but within the context of a performance the hierarchical stack of goal states for a performer is immense. Performers do not cease to monitor all other aspects of their existence just because they are playing music. However, within the subset that pertains to their involvement in a performance, it is possible that prioritising goals can be a dynamic process. Let us also remember that it is possible for the performer to be engaged with a goal state about which they have no conscious awareness. It

is this domain that I have explored in order to expand the traditional notions of a performance paradigm to include parameters that would allow the manipulation of behavioural mapping. This became more explicit as my work developed. Therefore, it feels appropriate to classify this aspect of my work as being implicit or explicit and to classify the performer's engagement with goal states determined by the work as being conscious or not conscious. It is worth noting that the combination 'implicit' and 'not conscious' exists all the time to some degree in all human activities not just improvised music making.

Figure 6.4 Performer Goal States

	Conscious	Not Conscious
Implicit		
Explicit		✓

In fig 6.4 a work which engages with a performer's goal states explicitly and on a subconscious level could be doing so using hypnotic suggestion either via an induced trance or by using Erickson style metaphoric stories.

6.2 Mosaic

I developed this interface for a collaborative performance with Dr Pauline Amos for the "Strange Noise" season held in Totnes during 2001. Pauline is primarily a visual artist, but also creates work in a performance setting. In this instance Pauline has pre-recorded some short extracts of dialogue. These were integrated into a larger sample bank from which the system autonomously made selections during the performance. Pauline improvised a narrative in response to the soundscape created by the system creating a dynamic between her real and virtual self.

The requirement was to create a visual interface which would behave in an unpredictable manner and create a soundscape with which she could interact. I captured a number of short samples of Pauline's voice and designed other audio samples which were combined into a single library. The visual interface was to give an indication of the system's current state but not an indication of what was to come. To this end I designed a simple eight by eight grid of

tiles, initially of similar colour. I based the amount of information that the interface communicated around Millers '7 plus or minus 2' rule of cognitive capacity. The eight rows of tiles represented four channels of sound, two rows for each channel. Each tile on the upper row represented a sound in the library and each tile on the lower row represented the volume of each channel; left to right representing low to high. The system randomly selected tiles on the grid after a fixed period of time (approximately 6 seconds). When a tile was selected it changed colour to green with only one green tile being allowed on each channel at a time. When another tile on a channel was selected it turned the existing green tile blue. Once a tile was blue it was no longer active and was ignored by the system. As each tile became green on a row, so the samples and relative volumes would change. The performance ended when all the tiles were blue. By looking at the grid Pauline could determine what possible volume levels and number of samples were left for each channel. Essentially the grid communicated eight pieces of information giving a picture of the current state of the system.

Figure 6.7 Mosaic Classification

Audio Visual Content					
CONTENT	Autonomous	Responsive	FORM	Autonomous	Responsive
Fixed	✓		Fixed		
Generative			Generative	✓	
Mixed			Mixed		

Performer Feedback and Response		
	Reactive	Predictive
Audio	✓	
Visual		✓

System Response		
	Static	Dynamic
Unified	n/a	n/a
Distributed	n/a	n/a

Performer Goal State		
	Conscious	Subconscious
Implicit	✓	
Explicit		

In this work the grid and musical content is fixed but the order is self organising. The performer reacts instinctively because there is no way of predicting what is going to happen

next. The only accurate prediction the performer can make is how much of the piece is remaining. There is a significant cognitive overhead for the performer if they are to use the interface to monitor the state of the system throughout the piece, but there is no imperative for them to do this. There is no facility within the work to explicitly alter the goal state of the performer.

Pauline's performance worked reasonable well from my point of view. She accompanied herself on an electric guitar, although I think in retrospect I would have preferred solo voice. The system produced a sonic backdrop of considerable interest even in sections when the voice was not present, but it was clear to me that the visual interface was either not visually engaging enough to hold Pauline's attention or was too complex to decode. This may have been a result of the very limited time she had to become acquainted with it. Although from an aesthetic point of view it produced an acceptable performance, as an experiment in performer interaction I regarded it as only a limited success.

6.3 Lost Hour

This work was created in collaboration with Nic Sandiland from Middlesex University. It was a site specific interactive installation as part of the *Nightwalking* conference, a commission by ResCen, the Centre for Research into Creation in the Performing Arts and the Greenwich Dance Agency, London 2002.

The premise of the piece was to explore the 'lost hour' between Greenwich meantime and British summertime. The installation comprised a sonar device for translating distance into MIDI, a line marked on the floor to represent the hour and a projection of a clock. Visitors could walk up and down the hour line and the sensor picked up their distance along the line and relayed it as MIDI messages to the software which changed the hands on the projected clock and triggered samples. As the participant walked the line, the clock went forwards or backwards in time creating changes in the soundscape.

Figure 6.8 Lost Hour Classification

Audio Visual Content					
CONTENT	Autonomous	Responsive	FORM	Autonomous	Responsive
Fixed	✓		Fixed		✓
Generative			Generative		
Mixed			Mixed		

Performer Feedback and Response			System Response		
	Reactive	Predictive		Static	Dynamic
Audio	✓		Unified	✓	
Visual		✓	Distributed		

Performer Goal State		
	Conscious	Subconscious
Implicit	✓	
Explicit		

The clock and soundscape were responsive to the position of the participant (performer) along the hour line. The responses were fixed and so the participant had no influence over the audio visual material, just when it was delivered. The work had a single mode of response which remained the same for the duration of the piece. Both the audio and visual feedback enabled the user to pre-empt the response to their next gesture after a brief period of engagement. The work made no attempt to explicitly change the goal state of the user. The user was mindful of all aspects of the environment.

6.4 Scribbler

This work was the first environment I developed that was responsive to sound. It comprises a piece of software that monitors an acoustic signal and makes a graphical response. The decisions about the nature of the mark making are based on the data it receives. The system choices, colour, probability of moving, thickness of line etc. are parameterised, so that the mapping between the sound and system can be altered. This work is something of an anomaly because it was not designed as a performance environment but as a durational piece that responds to sound over long periods and creates a type of 'acoustic trace', it is therefore

hard to classify its characteristics using this system. I have used this software in a number of environments, examples of which can be seen in Appendix 2.

Figure 6.9 Scribbler Classification

Audio Visual Content		
CONTENT	Autonomous	Responsive
Fixed		
Generative		✓
Mixed		

Audio Visual Content		
FORM	Autonomous	Responsive
Fixed		
Generative		✓
Mixed		

Performer Feedback and Response		
	Reactive	Predictive
Audio	n/a	n/a
Visual	✓	

System Response		
	Static	Dynamic
Unified	n/a	n/a
Distributed	n/a	n/a

Performer Goal State		
	Conscious	Subconscious
Implicit	n/a	n/a
Explicit	n/a	n/a

The output from this system is purely visual and within the process of execution it is hard to distinguish between form and content within it. There is very little that is fixed in terms of what the system produces either at a micro or macro level so classifying both its form and content as generative and responsive seems appropriate. Because there is no one person classed as a performer in this work the feedback is more an indication of the work's state rather than communicating information intended to stimulate human behaviour. I have classified it as reactive because I think it very unlikely that an observer could predict the work's response to its environment. The work has a unified response to its environment but the nature of the response changes in accordance with some probability parameters that are set at runtime.

6.5 Hexagram

This piece was created in collaboration with Michael McInerney for a performance with the ensemble 'Works' at Dartington. The ensemble comprised Michael on piano and shakuhachi,

Tony Moore, cello, and Jeff Cloke, electronics. The ensemble engaged in free improvisation while the system listened and generated sequences of hexagrams that were projected behind the performers. The projection also included a very slow moving Yin Yang symbol which transformed from black to white at a speed almost indiscernible to the human eye. When one transformation had taken place the piece ended. The performers could view the projection and therefore were aware of the cumulative effect their playing was having on the images being generated.

Figure 6.10 Hexagram Classification

Audio Visual Content					
CONTENT	Autonomous	Responsive	FORM	Autonomous	Responsive
Fixed			Fixed	✓	
Generative			Generative		
Mixed		✓	Mixed		

Performer Feedback and Response			System Response		
	Reactive	Predictive		Static	Dynamic
Audio	✓		Unified		✓
Visual		✓	Distributed		

Performer Goal State		
	Conscious	Subconscious
Implicit	✓	
Explicit		

In this work, although the output was only visual, it was responsive to the sound of the musicians. The overall structure was essentially fixed but the possibility of slight variation did exist. I therefore classified the form as fixed and not responsive to the environment as any variation would be virtually undetectable by the performers and would have no effect on the performance. The work gave a single stream of responses to the performer's actions but the responses were stochastic and therefore changed over time. There was no facility within the program to subliminally influence the performer's hierarchy of goal states.

This performance convinced me that I should progress my ideas with performance interfaces using solo performers. The members of the ensemble were very familiar with each others playing, and not with the responsive interface and so the vast majority of the interaction was inter-player. The visual projection added an extra dimension to the performance but was engaged with far more by the audience than the performers. Because the interface had a timed cycle, the musicians seemed a little uneasy in places, having to synchronise with an external time source. I was happy that the interface responded in quite a subtle way to the sound of the ensemble, but unfortunately there was no reciprocal effect on the musicians.

6.6 FreeKey

An early version of this piece was used in a concert by the Sam Richards ensemble GruveWelderz in 2003. More recently this piece was performed with pianist Dave Holland as part of the Totnes Jazz Collective's 10th Anniversary concert in Totnes 2005. The piece is designed to be used by a solo instrumentalist using a keyboard instrument. The piece uses imagery based on the keys of a keyboard which are animated, transformed and with which the performer interacts. The animation produces a soundtrack based on its own visual behaviour which is generated in real-time during the performance.

Audio Visual Content					
CONTENT	Autonomous	Responsive	FORM	Autonomous	Responsive
Fixed			Fixed	✓	
Generative			Generative		
Mixed	✓		Mixed		

Performer Feedback and Response		
	Reactive	Predictive
Audio		✓
Visual		✓

System Response		
	Static	Dynamic
Unified	n/a	n/a
Distributed	n/a	n/a

Performer Goal State		
	Conscious	Subconscious
Implicit		✓
Explicit		

Figure 6.11 FreeKey Classification

This work although not responsive to the sound of the performer did produce audio and visual material. The structure of the piece was fixed within certain limits but within the sections of the piece the content was largely generative. The interface is designed such that the animated agents on the screen create sonic material. The level of predictability in the manner in which they do this varies throughout the piece. Therefore the cognitive burden on the performer varies correspondingly. Although the work doesn't respond to the performer it could be regarded as responding to itself. There was no explicit facility within the program to subliminally influence the performer's hierarchy of goal states but the act of engaging with the visual interface and the process of predicting its behaviour places a cognitive burden on the performer which will inevitably influence their hierarchy of goal states. This was the result of an attempt to build something implicit into the interface which had this effect.

The performance by Dave Holland, documented on the CD was interesting on a number of levels. Firstly, the level of engagement between performer and the digital interface was much more focused than my experience of working with an ensemble. I observed Dave staring intently at the screen for large sections of the piece. It was interesting also to hear Dave reflect on his instinct to try and predict the behaviour of the interface and interact accordingly. This was particularly significant because it was my intention to try and illicit this type of behaviour from the performer by providing the visual agents with a trajectory that could be followed by the performer. I think it was significant also that Dave mentioned a pull he experienced towards recreating material from rehearsal. This indicated to me that the sonic material produced by the system did not vary enough from performance to performance, because far from leading Dave away from habitual playing it seemed to encourage him. I concluded that too high a proportion of the piece was fixed and that the generative aspect should have been more dominant and given greater freedom to influence the performer.

6.7 Milieu

This system represents a departure from the previous work. In all the previous work the systems created represent finished artefacts. This system, however, is a tool with which to

create finished artefacts and so there is a sense in which the resultant projects are instances of Milieu. There are general characteristics that all projects created using Milieu will share, which is an aspect I am comfortable with. After all, it could be said that there are general characteristics that all performances have in common. I feel that the tool is flexible enough to produce divergent work delivering a wide range of challenging opportunities for the performers that engage with it.

Because Milieu is not an end in itself, but rather a framework for creating other works, the classification of its characteristics are carried forward to works that are created with it. It is designed to create works comprising multiple sections of fixed duration with each section delivering generative content. The prototype system has a simple agent based architecture which spawns instances of agents based on a number of agent classes. The agents' behaviours, used to generate the visual content, are responsive to the sound of the performance environment and the sonic content is then generated in response to this. Throughout the performance there is the facility to alter the parameter mapping between incoming signal and the visual algorithms, and between visual and sonic algorithms. Performances created using this system are intended to explicitly allow the performance designer to interact with the goal states of the performer. The performances it has been used to generate have achieved this by using a pre-recorded hypnotic script prior to the performance. If required it is possible for this part of the process to be fully integrated into the performance.

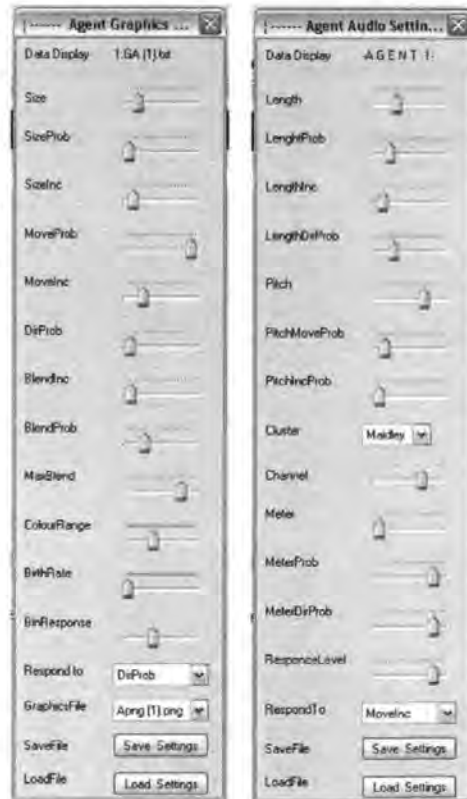


Figure.6.12 Milieu Parameters

A piece constructed using Milieu comprises one or more sections of fixed duration and each section contains up to eight conceptual agents. Each conceptual agent has around twenty-eight audio visual parameters that govern its internal state and behaviour. Figure 6.12 shows the parameters for one conceptual agent.

When the performance begins, instances of the conceptual agents are spawned on to the display space; these are referred to as child agents or agent instances. The rate at which they are spawned is set by the 'birth rate' attribute. Some of the conceptual agents' parameters set the level of probability of an agent instance exhibiting a certain type of behaviour. Therefore when new instances are created they share characteristics but not exact attribute values. For example a new instance of an agent may share a life expectancy with other instances from the same conceptual agent but wouldn't expire at exactly the same time. One of the visual parameters of a conceptual agent can be selected as being responsive to the incoming acoustic signal and the level of responsiveness can also be set. The audio material is generated via MIDI and can be set to respond to one of the visual attributes. This causes a type of chain reaction where the acoustic signal stimulates a visual response which in turn produces an audio response, the nature of which is determined by how they have been patched together. The sections and the conceptual agents can be saved independently so that they can be used again, either in the same piece or a different one. Because the piece is configured to run on a dual display it is possible for the configuration screens to be opened and parameters changed at run-time.

Figure 6.13 Milieu Classification

Audio Visual Content					
CONTENT	Autonomous		Responsive		FORM
Fixed					Autonomous
Generative			✓		Responsive
Mixed					

Performer Feedback and Response			
	Reactive	Predictive	Both
Audio	✓		
Visual			✓

System Response		
	Static	Dynamic
Unified		
Distributed		✓

Performer Goal State		
	Conscious	Subconscious
Implicit		
Explicit		✓

6.8 Milieu Performances

I have documented two pieces created with Milieu, one was performed at Concourse – Dartington 2005 by saxophonist Dave Murphy and the other was created and filmed in a lab situation, for demonstration purposes, with no audience (DVD Appendix 1). The first example is a piece entitled “Moving The Sun and The Traffic”.

The title of the piece represented an exploration of volition and control and was inspired by an account of a victim of brain damage who perceived everything they saw as being under their control. (Copelman 2003) The piece was intended to explore an improvising musician’s sense of conscious control in their performance.

Prior to meeting the performer, the basic design of the performance was constructed by creating performance and section configuration files. A title screen was designed and eight agents were configured. The graphics I used for the agents were largely selected from a number of files I had created when developing the system, I did not intend to use them in the final performance but actually most of them worked well together and so they remained. We

had been asked to perform for approximately fifteen minutes and so I decided to work with the idea of sixteen one minute sections. I wanted the sections to have a certain amount of continuity and not to have clearly marked transitions. I hoped to achieve this by including connecting material in adjacent sections, either by reusing agents or changing agents but still continuing with behavioural traits. I explored the idea of using onboard synthesis to provide the systems audio response but technical performance issues meant that the system felt more secure using an external sound module. I configured a number of patches using a Korg Triton which were then set to respond to midi channels corresponding to the agents. I spent a considerable amount of time matching the audio patches to the visual agents and then configuring the agent's responsiveness. The process was very compositional in nature, having to relate localised aesthetic decision making to wider more structural concerns. This process was very iterative and continued after I had started rehearsals with the performer. One decision that I didn't revisit was the number and duration of the sections, this was probably the first thing I decided upon and it endured until the performance.

The preparation with the performer for the Concourse performance comprised four stages. Stage one was an initial meeting at which the performer observed and experimented with the interface and decisions were made about the design of the performance. The second stage was a rehearsal using the configured system. At this stage the performer engaged with the first hypnotic script (Appendix 3). The script was related to improvisation in general and not specific to the piece, it was played to the performer on CD. The CD was listened to on headphones after which the rehearsal was undertaken. The third stage was the actual performance, where the performance environment was created in an appropriate space with sound and projection facilities. The performer again listened to an hypnosis script (Appendix 3) before embarking upon the performance. This time the hypnosis script was specific to the piece. Stage four was an interview, based loosely on a prepared questionnaire, in which the performer relayed their experience of performing the piece.

The Concourse performance was very encouraging. The performer's engagement with the interface was focused and unrelenting, moving around the performance space to explore the response of the system in relation to his proximity to the microphone. Dave explained afterwards that he used this technique to try and decode how the interface was generating material in response to his playing. Dave's experience of using the hypnotic script prior to the performance was very positive; he suggested that it would have been even more effective if the delivery of the script could have led straight into the performance. This was actually my intention, but logistically in this performance it was not possible. Because there was very limited time to try the system in the performance space, I was concerned that if the system generated very intense responses the balance between it and the performer would be problematic. This situation did not occur. I was happy with the sequencing of the section although their durations would have benefited with some adjustments, in particular some seemed very short. The most satisfying aspect of this piece for me was the response I got from Dave in the interview I conducted after the performance. Aesthetically there was room for improvement in terms of the systems audio visual output, but in terms of exerting influence on the performers improvisatory behaviour, I felt I had made real progress.

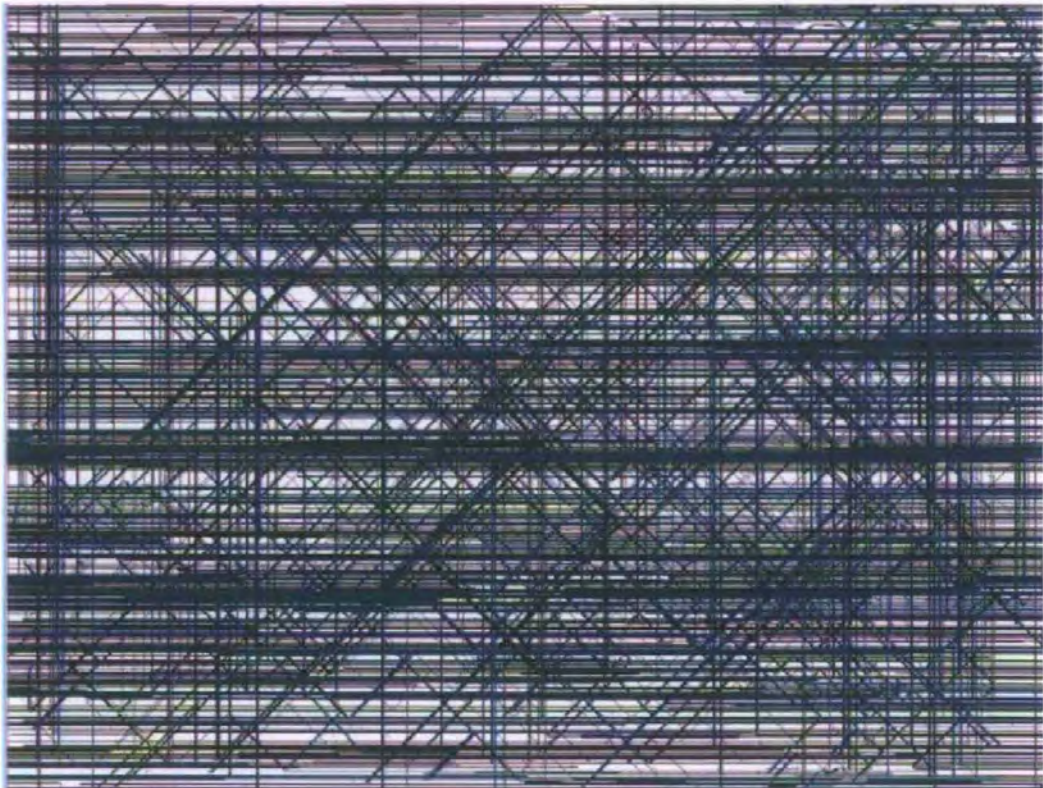
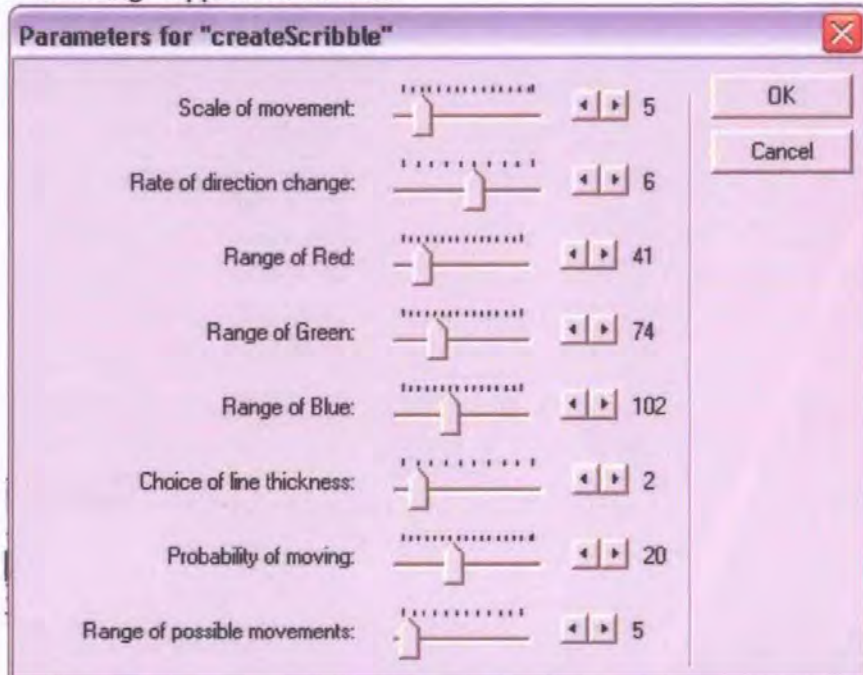
Appendix 1 – CD Rom and DVD

CONTENTS	
CD Rom	DVD Video
Introduction to the portfolio	Introduction 00:00
Musaic	Overview 03:00
performance information	The Parameter Space 09:45
system diagram	An Example System 13:15
screen capture	The Demonstration 19:15
project	The End 43:30
Lost Hour	
performance information	
system diagram	
screen capture	
project	
Scribbler	
system diagram	
screen capture	
project	
Hexagram	
system diagram	
screen capture	
project	
FreeKey	
performance information	
system diagram	
screen capture	
video clip	
project	
Milieu	
performance information	
system diagram	
screen capture	
video clip	
project	

Appendix 2 – Scribbler Output Examples

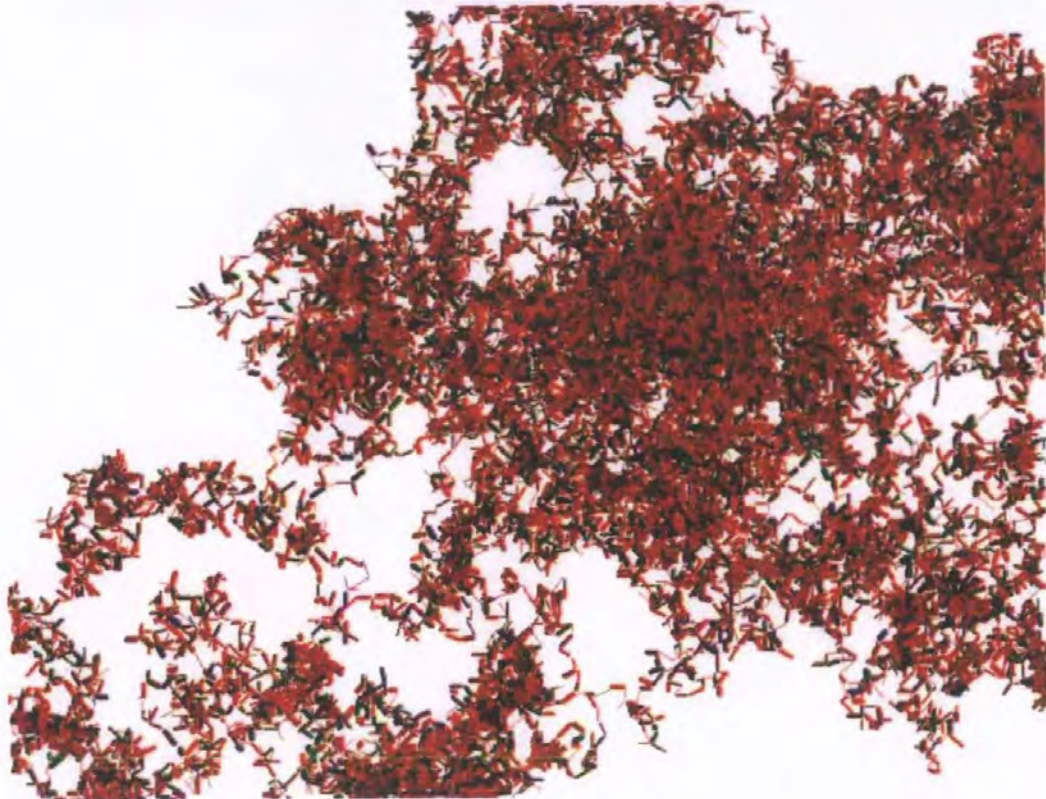
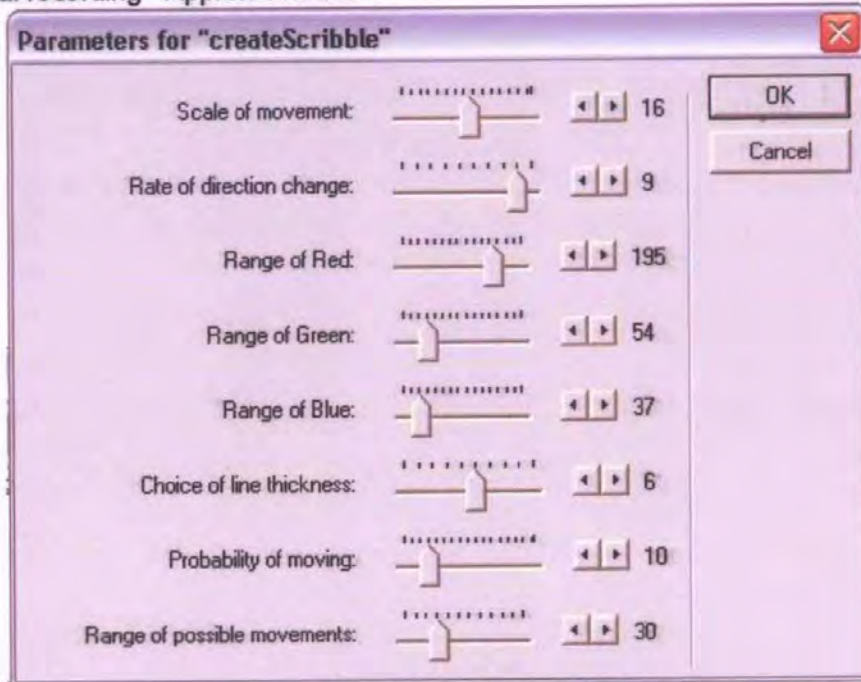
Example 1

Tube journey Paddington to Kings Cross – 2003
Binaural recording - Approx 45 minutes



Example 2

Flight from Exeter to Edinburgh – 2004
Binaural recording - Approx 1 house



Appendix 3 – Hypnotic Scripts

Improvisation Script 1

Structure

1. general empathetic conversation
2. brief description of Hypnosis
3. introduce the project
4. conversation focusing invoking an experience
5. eyes close, become relaxed
6. imagining a very positive playing experience
7. being aware of and savouring what has taken place
8. coming back in a happy, relaxed and satisfied state of mind

Techniques used

1. Embedded suggestion
2. Dependent suggestion
3. Presupposition
4. Illusory choice
5. Conscious/Unconscious split
6. Nominalisation

Script Outline

1. general conversation

- I know how busy you must be so I hope that as well as helping me out you'll get something from this experience, even if you just feel really refreshed at the end or have a really good relaxing nights sleep.
- So a big thank you and, I hope this will be beneficial to you in your playing and you'll have a really enjoyable time.

2. brief description of Hypnosis

- All you have to do is sit and relax here and listen carefully to what I say.
- Many people don't realise that they enter a hypnotic state many times during a day. These occur when your attention has a particular focus which diminishes the amount of sensory information that you are aware of. Reading a book on a train or watching a film are good examples.
- Don't expect anything miraculous to happen, all you need to do it turn your attention inwards and listen to my voice.
- Your conscious mind may or may not be aware that you have entered a trance, all you have to do is relax and enjoy the experience.
- This first session is about giving you the experience of an induction and allowing you to explore in your imagination a range of creative and inspiring musical experiences.

3. introduce the project

- Before you enter a nice deep relaxing trance let me say a few words about the project.
- I've been involved in various types of improvised music for many years and I've always been intrigued by the actual process of improvising.
- In some ways we invoke similar processes to improvisation when we speak *but in this case we're encoding and delivering linguistic information in real-time rather than musical material.*
- We know that our subconscious mind regulates many of our human subsystems including our behaviour. Sometimes we are conscious of its influence, perhaps when something scares us, and other times we are not, for instance when we are digesting food.

- I am interested in the sub-conscious' influence on the act of musical improvisation and its effect on the musicians perception of their performance.
- Improvising musicians from Evan Parker to Stephan Grappelli have used descriptions such as 'slightly shocking', 'a feeling of being out of yourself', 'being half asleep' etc. to convey the feelings they experience when conscious control of their playing has been relinquished to the subconscious.
- These moments can be quite rare but for many musicians it is the possibility of their occurrence that makes the practice of improvised music making so worthwhile.
- This project is an exploration of this phenomenon

4. conversation focusing invoking an experience

- So... this session is about allowing you to experience the exhilaration of a great musical improvisation with your imagination.
- Improvising works best when we're in the flow, when our conscious mind doesn't restrict what we play or guide us towards our habitual and mechanical modes of playing.
- You have almost certainly experienced this before, either as a player or as an audience member. Perhaps you aspire to achieve a certain subliminal state in your playing or perhaps deliver a particularly moving experience for your audience.
- In a moment I'm going to ask you to bring to mind a time and place when that might have happened or imagine a situation when it could happen.

5. eyes close, become relaxed

- Take a moment to make sure you are comfortable and that you feel well supported.
- All you need to do is relax and listen carefully to my voice and to what I'm about to say.
- Some people find it easier to enter a trance with their eyes shut, so if you haven't already, you may feel more comfortable to take a moment to close your eyes.
- That's right, you might like to concentrate on your breathing for a few moments, getting a sense of the relaxing ebb and flow of your breath as it enters and leaves your body.
- Good, just allowing your breath to naturally come and go and as each breath leaves you perhaps get a sense of becoming more relaxed.
- As musicians we are only too aware of unwanted tension in our bodies. Lets just spend a few moments moving our attention around our body, relaxing the various muscle groups and allowing us to enter beautifully peaceful state of mind.
- Perhaps you could start by guiding your awareness down to one of your feet, either the left or the right it doesn't matter, having a sense of how each of your toes feel. Allowing your toes to loosen up and feel comfortable and warm as the blood circulates freely around them.
- Now you might like to move your attention to the other foot and enjoy the faint tingling sensation as the toes on that foot loosen and relax.
- Take some time now to gradually move your awareness up your body, lingering on different areas as you go. You may move firstly to your calf muscles or your knee joint or your ankle, it doesn't matter which part of your legs you go to, just enjoying the sensation of relaxing where ever you send your attention. That's great.
- As each area of your body relaxes you may become more aware of the sound of your body, your heartbeat, the flow of air as you breath or possibly the faint rumbling of your stomach.

- Very often when the body relaxes in this way, all of the various parts function as they should and the flow of blood to the stomach allows it to relax and unwind.
- Perhaps you'd like to move your attention to the upper part of your body, maybe your arms or hands or possibly your shoulders or neck. Allowing your limbs to perhaps give a little bit as your muscles loosen and a beautifully warm glow flows around your body. That's great.

6. imagining a very positive playing experience

- Ok, very good, now as you enjoy a deep sense of calm perhaps you could bring to mind a situation in which you are improvising on your instrument. You may evoke a memory of a performance that you are particularly proud of or it may be an imaginary performance.
- Which ever it is, it would be good to get a sense of all the things that make your performance so special. You may like to turn your attention to the sounds of the performance space, perhaps there are sounds from an audience or from other musicians, possible ambient sounds in the space or sounds entering the space from outside. Get a real sense of your contribution to the sonic soundscape of the performance space, whether it be inside or outside, quiet or noisy.
- notice how the tips of your fingers feel as you touch your instrument or any other part of your body that comes into contact with your instrument. You can allow yourself to experience pleasure from the physicality of your instrument
- just spend a moment enjoying the sounds and the silences that emanate from your instrument and focus on the relationship between them and the emerging soundscape.
- you may get a sense of how it feels when all the various elements fall into place, it may be an exhilarating or ecstatic feeling or perhaps a feeling of complete freedom.
- imagine the sense of liberation you enjoy when the music flows from your sub-conscious, without the need to think about it. You may have a feeling of relaxed confidence or feel emotionally elevated
- you may notice the ease with which you can produce the most engaging and satisfying sounds on your instrument
- part of the enjoyment and satisfaction of your performance is perhaps due to the security you feel because you have faith in your subconscious to produce new and interesting music.

7. being aware of and savouring what has taken place

- You may want return to a feeling of peaceful relaxation and allow the exhilaration of your special performance to gradually diminish into calmness.
- You may want to remember the sense of ease with which you played and the sense of confidence you felt during your performance so that you can recall it on other occasions
- As the sounds fade you may take a moment to savour and enjoy a deep sense of satisfaction about what you have just played.
- You may feel a sense of contentment or reassurance that your subconscious is there for you to call upon when ever you want.

8. Coming back in a happy, relaxed and satisfied state of mind

- Gradually begin to sense the room around you, the sounds, the temperature
- When you're ready you may make some small movement to put you back in touch with where you are
- In your own time open your eyes and have a stretch

Improvisation Script 2

Structure

1. get comfortable with context
2. background information about piece, mapping
3. eyes close - relaxation/induction
4. talk through the piece
 - focus on visual interface, allow it to determine your musical behaviour
 - create a sense of trust in subconscious to handle playing
 - create positive state of mind to begin the piece
5. coming back feeling stimulated and looking forward to playing

Techniques used

1. Embedded suggestion
2. Dependent suggestion
3. Presupposition
4. Illusory choice
5. Conscious/Unconscious split
6. Nominalisation

Script Outline

1. get comfortable with context

- I'm really please that you've agreed to be involved in this project and I really am very grateful for the time and effort you've put into it.
- I want to just give you a bit more information about this piece so that you will be really happy and relaxed with what's going on and so that you'll feel focused and inspired when you play.

2. background information about piece, mapping

- You have already seen the interface in rehearsal and have seen how the agents on screen display differing type of behaviour.
- The agents are responsive to the ambient sound of the room which affects a number of parameters. These parameters are then mapped onto the agents behaviour.
- Each behaviour has its map set slightly differently which produces the differing behaviour.
- You may see a parallel with how people behave in everyday life, two people may react very differently to an identical situation because their internal behavioural maps have been setup differently.
- Some elements of our behavioural mapping enter our conscious awareness and some don't. For instance, I may be aware that entering a small space makes me uneasy but I may be completely unaware that driving makes me aggressive. Others may notice but I may not be aware myself.
- When an improvising musician stands up to play in front of an audience there behaviour will inevitably be affected by a huge range of parameters, ranging from how much practice they have done to how hungry they are, and it is via their behavioural mapping that these parameters will influence their performance.
- In this performance the audio visual interface has effectively expanded your parameter space and consequently placed an additional demand on your mapping mechanism.

- This is a wonderful opportunity for you to see what this mapping produces in terms of your musical expression.
- PAUSE
- I want to just take a few moments to for you relax in preparation for the performance and to make a few suggestions to help you get the most from this experience.

3. eyes close - relaxation/induction

- OK, make sure you feel comfortable and that you feel well supported.
- All you need to do is relax and listen carefully to my voice and to what I'm about to say.
- Allow any ambient noised to just come and go, enjoying them as they pass and then returning back to my voice, keeping focused on my voice and to what I have to say.
- If you haven't already, you might like to close your eyes to help you concentrate on what I am about to say.
- That's right, you could take a few moments to focus on your breathing, getting a sense of the tension and release of your breath as it flows in and out of your body.
- PAUSE
- Good, this is a great time to enjoy the anticipation of the performance and to enjoy a feeling of optimism about your playing
- just allowing your breath to naturally come and go and as each breath leaves you can perhaps allow yourself to become more relaxed.
- I just want you to turn your attention to the various muscle groups you call upon when you play your instrument.
- Perhaps you could start with your fingers, just getting a sense of any stiffness or tension you are holding in your joints. Just being aware of that for a few moments before letting it release. You may get a sense of it flowing away or evaporating or what ever, but just savour that sense of release.
- In your own time, you might like to move your awareness to other areas of your body associated with playing your instrument. Your forearms or elbows perhaps or maybe your neck, shoulders and face.
- PAUSE
- As you move from area to area enjoy the exquisite sense of release as stiffness and tension is replace by strong fluid mobility and an overwhelming sense of ease of movement.
- As each area becomes fluid and mobile you may experience an enhanced sense of confidence that your physical apparatus is well lubricated and responsive and ready to fly into action.

4. talk through the piece

- In preparation for the performance you are about to give, you might like to imagine the performance environment. Perhaps you can visualise yourself in relation to the microphone and the screen that you are watching. It doesn't have to be exactly as it is in tonight's performance but just a sense of the relationship between the various components of the performance environment.
- You may like to have a sense in your mind of a giving and receiving relationship with the animated agents. Of receiving visual stimulation and offering musical material, in a spirit of sharing and mutual support.
- As you consider these relationships you feel an increasing sense of clarity about your relationship with the sonic landscape of the performance. You can perhaps feel what its like to have clear sense of when and what to play and feel

confident in playing your part in the creation of a rich and interesting performance.

- You have perhaps already realised that your positive and optimistic feelings towards this performance are based on your complete trust in your sub conscious to stimulate your playing while your conscious mind is engaged with the audio visual interface.
- Imagining still then, the performance as it unfolds, feel the sense of euphoria and amazement you experience as your engagement with the interface allow your playing to develop in new and unpredictable ways.
- Just stay with this feeling for a moment, feeling happy to be taken by the music to new territory, responding to the demands of your subconscious with ease and clarity and technical precision.
- PAUSE
- As and when these feelings return to you during your performance, run with them, embrace them and enjoy them and when the performance is over you may find that the positive feelings you have experienced will remain with you as a resource for you to draw upon in your future playing.
- PAUSE
- Take your attention back to the present time and take a few moments now to prepare yourself for the opening of the performance.
- You may feel the positive affects of adrenaline or a sense of expectation but you are certainly likely to feel a quiet calm confidence in your ability as a player and in your ability to thrive in this performance environment.
- You are likely to be quite relaxed about the opening sequence and happy that you will instinctively start playing when the time is right and that this instinctively responsive mode of playing will continue for the duration of the performance.
- It is highly likely that you will be aware of the timing of the sixteen one minute sections and that the ending of the piece will provoke a clear sense of closure in you and in your playing.

5. Coming back feeling stimulated and looking forward to playing

- OK, now, feeling stimulated and ready to play, it's time to bring your attention back to the room you're in and to the present time.
- Make yourself aware of the room around you, the sounds, the temperature
- When you're ready you may make some small movement to put you back in touch with where you are
- When you're ready open your eyes, loosen your arms and legs and get your circulation flowing nicely.

Improvisation Script 3

Structure

1. Empathetic Introduction
2. Relaxation
3. Explore the idea of a connection/relationship/association/link
4. Visualise a cross town train connection
5. Explore the idea of a train connection
6. Introduce the idea of a train connection as a metaphor for improvising
7. Talk through relationship with agents
8. Leaving a positive impression
9. Beginning the performance

Techniques used

1. Embedded suggestion
2. Dependent suggestion
3. Presupposition
4. Illusory choice
5. Conscious/Unconscious split
6. Nominalisation

Script Outline

1. Empathetic Introduction

- this recording is intended to prepare you for the performance you are about to give.
- having listened to this recording you will feel confident in undertaking this performance and will feel comfortable with your relationship with the audio visual interface with which you will be interacting
- it is quite possible that during the performance you will have no recollection of the things that have been suggested to you in this recording yet what I am about to tell you may have a significant influence on your improvisation
- the effect of listening to this recording could be very profound or very subtle, either way it's effect will manifest itself in your playing.
- it is important to enjoy and embrace the positive effect this has on your playing regardless of the intensity of it's influence.
- enjoy the stimulation you feel when the performance is over even if it is not clear to you what the effect on your playing has been.

2. Relaxation

- before we begin to explore the nature of this performance it may be a nice idea to adopt a comfortable position, feeling well supported
- it may be easier to engage with this process if you take a few moments to close your eyes.
- just get a sense of your eye lids for a few moments, take your awareness to your eyes and your eye lids and air on your eyes and the weight of your eye lids
- after a few moments, if you haven't already you may like to gently close your eyes, just feeling the weight of your eye lids pulling your eyes closed
- just enjoy that feeling of your eyes being closed, the weight of your eye lids evaporating into a relaxed feeling around your eyes
- get a real sense of the tension in your eyes falling away, and as it does the relaxation you experience starting to emanate from your eyes to your forehead and your cheeks

- you may want to just hold on to that exquisite feeling and the tension you are holding in various parts of your face begins to drop away
- Pause
- you may bring to mind the ripples in a pool of water gently rolling outwards as the relaxing feeling begins to spread outwards around your face
- pause
- allow the release to extend to your mouth, your nose and chin enjoying the growing sense of relaxation you feel
- just take a few moments to enjoy the ripples as they release any tension you might be holding, perhaps in your neck or shoulders or perhaps lower down your body.

3. Explore the idea of a connection/relationship/association/link

- as the tension is released from your various joints and muscles your sense of relaxation becomes deeper and deeper
- with each muscle or tendon that releases tension you might like to contemplate the nature of connectedness. Joints connecting bones, tendons connecting muscles and so on.
- in one sense connections are the fabric of relationships between components
- you may like to contemplate the potential for connections to create new relationships between entities, new connections forming new relationships

4. Visualise a cross town train connection

- train travellers often have to make connections during the course of a journey
- you might like to take a few moments to get a sense of making a train connection, the station smells, the hard concrete floors, perhaps tube trains or buses, taxis or bustling streets.
- you may hear the sound of chattering voices but not hear what they're saying, foreign languages or maybe children laughing and shouting.
- all these vivid sounds and images and feelings contribute to the sense of making a connection

5. Explore the idea of a train connection

- As you hear the sounds and sense hustle and bustle you may begin to appreciate the many possible connection routes
- you may like to contemplate the possibility and potential of making new connections
- Surprise encounters could alter the route or change connection
- New connection could lead to the same destination by a very different route
- New connection leads to a new destination

6. Introduce the idea of a train connection as a metaphor for improvising

- in improvisation it is often exciting to end up somewhere new
- making new connections gives the enjoyment of undertaking a different journey
- we often experience the buzz of anticipation of potential possibilities when well established connections are abandoned
- embracing encounters with new provocations can bring the delight and stimulation of entering new territory.
- unlike travelling, in improvisation you can feel confident that new connections always lead to a safe destination even if they are unfamiliar

7. Talk through relationship with agents

- in the interface you are about to engage with the agents will exert a certain level of influence over the journey
- you may like to think of the agents as presenting opportunities
- you will find the agents reacting to and possibly provoking your musical behaviour.

- trusting in your subconscious will allow your performance to flow naturally without the need for conscious control or force
- the path as it unfolds is always your path even though it may be unfamiliar
- although at some points you may feel stretched as a performer you can always feel safe and stimulated in any unfamiliar situation you may find yourself in

8. Leaving a positive impression

- when the performance is over you may feel challenged even though you have been enriched by your experience
- your connections will have made the journey and completing that journey may leave you with a sense of peace and contentment
- the connections you have forged will remain with you and give you the base from which to explore further in other performances
- your inner confidence will continue to grow as you accept whatever journey is presented to you and whatever connections you create

9. Beginning the performance

- you may become aware that the interface has started and the time has come for you to begin interacting with it.
- you may like to spend a few moments absorbing the sonic landscape in which you find yourself, the sound of the agents, the ambience of the room, the journey
- when you feel comfortable you may like to begin to engage with your instrument, getting a sense of what it feels like.
- gently beginning to press keys or valves or whatever, feeling the temperature of its exterior, its weight.
- you could just move into a playing position, feeling your breath and a sense of anticipation of entering the performance.
- as your anticipation grows you may feel your breathing becoming a little more pronounced or maybe erratic.
- whenever you feel happy, when the time is right, when the moment moves you, enter the performance

Appendix 4 – Milieu Source Code

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Milieu – A Technical Overview

All performance environments created using Milieu work using the same basic principle. A performance comprises a number of sections; each section has a fixed duration and can have allocated to it a maximum of eight agents. The agents have both visual and sonic behaviour which can be configured when the piece is being designed. The agent's behaviour is configured via a number of parameters which setup its general visual and sonic behaviour. When the system is activated the agents will spawn many instances of themselves on the screen and each instance will inherit the visual and sonic behaviour from the parent agent's parameter set. Most of the parameters are probabilistic, which means that none of the instances of the agents will share exactly the same behaviour, they will just inherit general characteristic.

An important aspect of the system is the processing of the acoustic signal that the computer accepts from the performance space, which is undertaken using a Fourier transform. Each agent has a parameter which sets the range of frequencies that it will respond to. It also has another parameter that sets how responsive the agent will be to the incoming signal. One of the agent's parameters must be selected to be controlled by the acoustic signal, in which case its on-screen parameter setting is overwritten by the data arriving from the acoustic signal.

The audio behaviour doesn't have a parameter that is directly controlled by the acoustic signal but it must have one parameter that is linked to one of the graphical parameters. This means that if that graphical parameter is changed by the agent it will cause a change in the acoustic parameter to which it is linked. If the graphical parameter happens to be the one which is controlled by the acoustic signal, then indirectly the sonic parameter to which it is linked will also be affected by the acoustic signal.

The chain of control that is setup using the system's parameters is at the heart of its configuration and use. It is possible to create situations where the agent's visual and sonic behaviours respond in very different ways to the acoustic signal and in so doing create agents that respond obviously to the acoustic signal, not obviously or not at all.

How Milieu Is Used

The Milieu development tool is not intended for distribution. It is a personal tool which I have developed for use in my own work and work I have undertaken in collaboration with others. Using the tool to create performance environments relies quite heavily on my knowledge of its inner workings and the structure and location of the various data files that it uses. This guide is intended to describe the process of engaging with the tool using a simple, iterative approach to designing a new performance environment.

Introduction

This guide will go through the various stages of creating a performance system using the Milieu software. In order to simply communicate the concepts underlying this software tool I will use a design methodology based on four phases. This is offered as an exemplar and is by no means the only approach that could be adopted. The first phase involves making certain 'global' design decisions about the performance, the second involves the creation and configuration of the animated agents and the third is the development of the form or narrative of the piece. The design process is quite iterative and so it is inevitable that these three phases will be revisited as the system develops. Once the narrative has been developed that fourth phase evolves the performer's behavioural map by means of constructing and recording a trance induction script.

Phase 1

Milieu creates performances that comprise any number of durational sections with each section being of fixed length and containing up to eight audio visual agents. The first phase is therefore to setup the various sections and give them their durations. The performance information is held in a text file inside the performance folder. Each section of the piece must have a folder placed inside the sections folder, and the folder name must be identical to the section as referred to in the piece (performance file). I usually begin this process by copying sections from previous systems and renaming them, then editing the performance file to add the new names and durations.

Phase 2

Each section has to be allocated a number of agents, up to a maximum of eight. There are two text files inside each of the section folders which contain a list of the agents being used in that section. The various sections need not necessarily use the same agents and so a system comprising two sections could use sixteen different agents, eight in the first section and eight in the second. In this phase each agent is individually configured. The easiest way to do this is to view the agents one at a time inside a section, alter the parameters until the desired result is achieved and then save the agent in the agentProfiles folder. The audio profiles and visual profiles are held in separate files. The parameters and their function are set out below.

Phase 3

Phase three is when the agents are combined and added to sections. The easiest way to do this is to edit the AAS.txt (audio) and GAS.txt (visual) files inside each of the sections folders. Most of the configuration files can be edited quite simply using a text editor apart from the agent profile. The agent profile files are quite complex and I have found it much safer to make alterations to an agents profile from within the system using the configuration windows. This phase tends to rely on trial and error to achieve the desired audio visual response from the child agents, I tend create the agent configurations one at a time and compiling a library of agents before combining them in phase 4.

Phase 4

In this phase the concept of the piece in terms of the performer's behavioural response to the interface is developed. The characteristic of the audio visual activity and type of interactive relationship the performer will have with the system are codified in a written narrative which is then recorded. This narrative uses various techniques to influence the performer's behavioural response to the interface. The recording is then played to the performer either before the piece or after the piece has commenced.

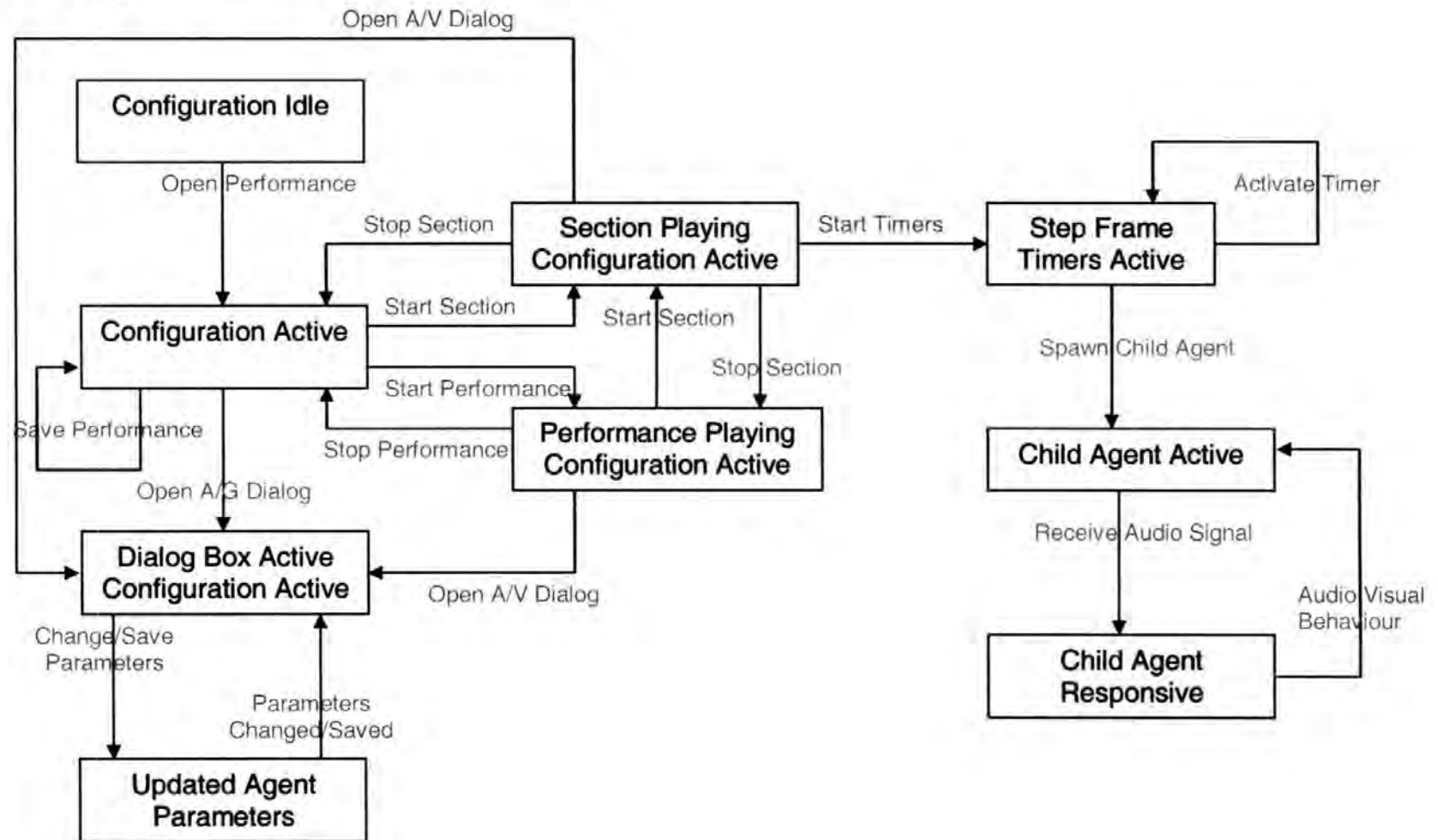
Visual Parameters

AgentSize	Initial size of child
AgentSizeProb	Probability of size change
AgentSizeInc	The increment of size change
AgentMoveProb	The probability of the agent moving position
AgentMoveInc	The increment of each movement
AgentDirProb	The probability of changing direction
AgentBlendInc	The increment by which the agent will decay
AgentBlendProb	The probability of the agent decaying
AgentMaxBlend	Maximum decay a child agent is born with
AgentColourRange	The range of colours change
AgentBirthRate	Rate at which child agents are instantiated
AgentBinResponse	Frequency range the child is most responsive
AgentResponse	Parameter that is affected by audio stream

Audio Parameters

AudioLength	The initial length of each MIDI event
AudioLengthProb	The probability of the length changing
AudioLengthInc	The increment for the change of length
AudioVolProb	The probability of the volume changing
AudioPitch	The fundamental pitch for the child agent
AudioPitchMoveProb	The probability of moving to another pitch
AudioPitchIncProb	Distance from the current pitch to the new pitch
AudioMode	The pitch cluster for the child agent
AudioChannel	The midi channel that child agent sends data on
AudioMeter	The speed of the inner pulse of the agent
AudioMeterProb	Level of deviation from the pulse
AudioSendData	Parameter that gets visual data
AudioResponseLevel	The response level to the incoming data
AudioGetData	The visual parameter that passes incoming data

Structure Diagram



Milieu Source Code

Movie Script

```
--this script hold the handlers that call the initialisation and close down routines. There are also hadlers to trap keyboard activity and run dialog boxes.
--the main handlers for loading performance data and moving from section to section in the performance are also here
global gDebugMode,gStartStop
--graphics globals
global gChildList,gWhichSprite,gAgentSettings -- list to hold current agent setting to seed new child agents
global sl, sr, st, sb, sheight,swidth, gPosH, gPosV,gOldPosV,gOldPosH, gAgentCounter, gAgentSNumList
--extra fft & midi globals
global gFFTCOUNTER, gasFFTObj, gSampleValues, gFFTVValues, gMIDIoXtra
-- MIAW globals
global gWindowName, gPerformanceMovie
-- agents graphics dialog box globals
global gGraphicSettingDialog, gGraphicDialogPropList, gGraphicDialogItemList, gBigAgentList
global gGraphicParamList, gGraphicRealPosList, gGraphicParam, gGraphicList,gGraphicMemberList
-- agents audio dialog box globals
global gAudioSettingDialog, gAudioDialogPropList, gAudioDialogItemList
global gAudioParamList, gAudioRealPosList, gRealPos, gAudioParam, gAudioList
-- shared between graphic and audio dialog
global gAgents, gSections, gAgentAudioList,gAgentTimerList,gAgentTimerScripts,gOpenDialog
-- performance dialog box globals
global gPerformanceSettingDialog, gPerformanceDialogPropList, gPerformanceDialogItemList
global gPerformanceParamList, gPerformanceRealPosList --, gRealPos, gAgents
global gPerformanceParam, gPerformanceSections, gPerformanceList,gDurationList,gSectionName
-- performance globals
global gMasterSeconds, gMasterMinutes,gPerformanceTimer, gDisplayTimer,gPerformanceParamNum,gSectionChoice
global gPlayingSection,gSectionDuration,gPlayingPerformance,gCurrentSection,gTotalTimeSeconds
global gSplashGraphic,gAudioScript,gAudioBacking
-- global file paths
global gGraphicsFilePath,gAudioFilePath,gGraphicsSettingPath,gAudioSettingPath,gPerformanceSettingFileList
global gNewFileName, gSectionPath,gAgentGraphicList,gSectionFileName,gCDROM
```

on startMovie

```
gDebugMode = 1
gStartStop= false
initialiseGlobals
initialisePaths
initialiseXtras
initialiseController
end
```

on openPerformance

```
screenClean
tempData = openAndReadText("")
if tempData<> VOID then
  member("performancefilename").text = gNewFileName
  gPerformanceList = value(tempData)
  listToField(gPerformanceList,"sectionList",1)
  listToField(gPerformanceList,"durationList",2)
  loadGraphicFiles
  --load sections into one big list, to solve hiatus problem
  repeat with i = 1 to gPerformanceList.count
    gSectionChoice = i
    loadSectionSettings i
    agentGraphicDialogSetup(gAgents, gGraphicParam, gSections)
    agentAudioDialogSetup(gAgents, gGraphicParam, gSections)
    gBigAgentList[1].append(gGraphicDialogPropList)
    gBigAgentList[2].append(gGraphicDialogItemList)
    gBigAgentList[3].append(gGraphicRealPosList)
    gBigAgentList[4].append(gAudioDialogPropList)
    gBigAgentList[5].append(gAudioDialogItemList)
    gBigAgentList[6].append(gAudioRealPosList)
  end repeat
  loadAllSectionData 1
else
end if
```

```
getSetupMedia 1
getSetupMedia 2
getSetupMedia 3
end
```

on getSetupMedia whichMedia

```
case whichMedia of
  1: message = "Please select backing audio file if desired"
  2: message = "Please select script audio file if desired"
  3: message = "Please select splash graphic if desired"
end case
alert message
tempfilename = getNewFileName()
if tempfilename <> VOID then
  case whichMedia of
    1: gAudioBacking = tempfilename
    2: gAudioScript = tempfilename
    3: gSplashGraphic = tempfilename
  end case
end if
end
```

on loadGraphicFiles

```
gGraphicMemberList=[]
gGraphicList = getfiles(gGraphicsFilePath)
if gGraphicList = [] then
  alert the moviename&"": No Graphics File"
else
  repeat with i = 1 to gGraphicList.count
    newmember=the number of members of castLib("graphics")+1
    importFileInto(member(newmember,"graphics"),gGraphicsFilePath&"\ "&gGraphicList[i])
    gGraphicMemberList.append(member(newmember,"graphics").name)
  end repeat
end if
```

end

on savePerformance

```
repeat with i = 1 to member("sectionList").line.count
  gPerformanceList[i][1] = member("sectionList").line[i]
  gPerformanceList[i][2] = member("durationList").line[i]
end repeat
saveText string(gPerformanceList)
end
```

on checkKey

```
--callDialogBox the Key
case the Key of
  SPACE:
    if gStartStop = True then
      if the windowlist.count = 0 then
        alert "no window to close"
        halt
      else
        (the activewindow).forget()
      end if
    else
      go next
    end if
    gStartStop = True
  end case
end case
```

end

on callDialogBox whichBox

```
--using numbers to move to scenes
case whichBox of
  1: -- PERFORMANCE
    if gOpenDialog[whichBox]=false then
      if objectP( gPerformanceSettingDialog ) then
```

```

    Initialize(gPerformanceSettingDialog, [#windowPropList:gPerformanceDialogPropList,#windowItemList:gPerformanceDialogItemList])
    WindowOperation( gPerformanceSettingDialog, #show )
end if
gOpenDialog[whichBox]=true
else
    gPerformanceSettingDialog.stop(TRUE)
    gOpenDialog[whichBox]=false
end if

2: -- GRAPHIC
if gOpenDialog[whichBox]=false then
    if objectP( gGraphicSettingDialog ) then
        Initialize(gGraphicSettingDialog, [#windowPropList:gBigAgentList[1][gSectionChoice],#windowItemList:gBigAgentList[2][gSectionChoice]])
        gGraphicDialogPropList.name = "Graphic:"&gSectionName
        WindowOperation( gGraphicSettingDialog, #show )
    end if
    gOpenDialog[whichBox]=true
else
    gGraphicSettingDialog.stop(TRUE)
    gOpenDialog[whichBox]=false
end if

3: -- AUDIO
if gOpenDialog[whichBox]=false then
    if objectP( gAudioSettingDialog ) then
        Initialize(gAudioSettingDialog, [#windowPropList:gBigAgentList[4][gSectionChoice],#windowItemList:gBigAgentList[5][gSectionChoice]])
        gAudioDialogPropList.name = "Audio:"&gSectionName
        WindowOperation( gAudioSettingDialog, #show )
    end if
    gOpenDialog[whichBox]=true
else
    gAudioSettingDialog.stop(TRUE)
    gOpenDialog[whichBox]=false
end if

4: midiShutUp
0: cleanup
SPACE: --go "s1"

```



```
    otherwise:
        --alert "Key not programmed"
    end case
end
```

on displayTime

```
    gTotalTimeSeconds = gTotalTimeSeconds - 1
    timeStamp gTotalTimeSeconds
end
```

on timeStamp secs

```
    gMasterMinutes = integer(secs) / 60
    member("time").text = "Total Time Remaining - "&gMasterMinutes&" "&string(integer(secs-(gMasterMinutes*60)))
end
```

on getReadyToRumble whichType

```
-- trying to distinguish between play section and play performance
if whichType = "section" then
    if the windowlist.count=0 or (the windowlist.count=1 and gCDROM = true) then --1 then
        --show time on controller window
        gTotalTimeSeconds = gPerformanceList[gSectionChoice][2]
        timeStamp gTotalTimeSeconds
        loadSection
    else
        startSection
    end if
else if whichType = "performance" then
    gSectionChoice=1
    if the windowlist.count= 0 or (the windowlist.count=1 and gCDROM = true) then --1 then
        -- tot up the times of all the sections
        gTotalTimeSeconds=0
        repeat with i = 1 to gPerformanceList.count
            gTotalTimeSeconds = gTotalTimeSeconds+gPerformanceList[i][2]
        end repeat
    end if
end if
```

```
end repeat
timeStamp gTotalTimeSeconds
loadSection
else
startPerformance
end if
end if
end
```

on loadSectionSettings choice

```
gSectionFileName = member("sectionList").line[choice]
gSectionName=gSectionPath&gSectionFileName
gPerformanceList[choice][1]=gSectionName
gSectionDuration = integer(member("durationList").line[choice])
gPerformanceList[choice][2]=gSectionDuration
member("sectionList").line[choice].hilite()
member("durationList").line[choice].hilite()
gAgentGraphicList = value(openAndReadText(gSectionName&"GAS.txt"))
gAgentAudioList = value(openAndReadText(gSectionName&"AAS.txt"))
listToField(gAgentGraphicList, "agentGraphicList")
listToField(gAgentAudioList, "agentAudioList")
gAgents = gAgentGraphicList.count
end
```

on loadSectionParameters choice

```
gGraphicDialogPropList=gBigAgentList[1][choice]
gGraphicDialogItemList=gBigAgentList[2][choice]
gGraphicRealPosList=gBigAgentList[3][choice]
gAudioDialogPropList=gBigAgentList[4][choice]
gAudioDialogItemList=gBigAgentList[5][choice]
gAudioRealPosList=gBigAgentList[6][choice]
end
```

on loadAllSectionData choice

```
gSectionChoice = choice
db "LOADALLSECTIONDATA - gSectionChoice: " & gSectionChoice & " gAgents: " & gAgents
loadSectionSettings choice
loadSectionParameters choice
end
```

on loadSection sectionName

```
put "loadSection"
gPerformanceMovie = window gWindowName
if the deskTopRectList.count > 1 then
  gPerformanceMovie = window gWindowName
  db the deskTopRectList.count&" displays available"
  gPerformanceMovie.rect = the deskTopRectList[2]
else
  --just for the CD ROM
  gPerformanceMovie = window "Performance1"

  db "Only one display"
end if
open gPerformanceMovie
end
```

on startSection

```
put "start Section"
if gPlayingSection = FALSE then
  starttimer
  gDisplayTimer = timeOut("timer2").new(1000, #displayTime)
  gPlayingSection = TRUE
  Tell gPerformanceMovie to startTimers
else
  gPlayingSection = FALSE
  if gOpenDialog[2]=true then
    callDialogBox 2
```

```

    end if
    if gOpenDialog[3]=true then
        callDialogBox 3
    end if
    cleanUp
end if
end

```

on startPerformance

```

put "start Performance"
if gPlayingPerformance = FALSE then
    starttimer
    gDisplayTimer = timeOut("timer2").new(1000, #displayTime)
    gPlayingPerformance = TRUE
    Tell gPerformanceMovie to startTimers
else
    gPlayingPerformance = FALSE
    Tell gPerformanceMovie to stopTimers
    cleanUp
end if
end

```

on idle

```

if gPlayingSection= TRUE and the timer >= gSectionDuration*60 then
    cleanUp
else if gPlayingPerformance = TRUE then
    if the timer >=gPerformanceList[gSectionChoice][2] *60 then
        gSectionChoice = gSectionChoice+1
        if gSectionChoice > gPerformanceList.count then
            gSectionChoice=1
            loadAllSectionData gSectionChoice
            member("sectionList").line[gSectionChoice].hilite()
            member("durationList").line[gSectionChoice].hilite()
            gPlayingPerformance=FALSE
        end if
    end if
end if

```

```

Tell gPerformanceMovie to stopTimers
Tell gPerformanceMovie to goBackToStart
db "end of section list, stop timers and back to start"
else
member("sectionList").line[gSectionChoice].hilite()
member("durationList").line[gSectionChoice].hilite()
loadAllSectionData gSectionChoice
gCurrentSection = gSectionChoice
db "IDLE - section no: "&gSectionChoice&" agents: "&gAgents&" name: " &gPerformanceList[gSectionChoice][1]&" timer:
"&gPerformanceList[gSectionChoice][2]
Tell gPerformanceMovie to startTimers
starttimer
if gOpenDialog[2]=true then
callDialogBox 2
callDialogBox 2
end if
if gOpenDialog[3]=true then
callDialogBox 3
callDialogBox 3
end if

end if
end if
end if
end

```

on cleanUpController

```

gPerformanceTimer.forget()
gDisplayTimer.forget()
gMasterSeconds = 0
gMasterMinutes = 0
end

```

on stopMovie

```
screenClean  
cleanUpCasts  
cleanUp  
killGlobals  
cleanUpXtras  
end stopMovie
```

on screenClean

```
member("Time").text = "Time Remaining - 0:0"  
member("sectionList").text = ""  
member("durationList").text = ""  
member("display1").text = ""  
member("agentGraphicList").text = ""  
member("agentAudioList").text = ""  
member("performancefilename").text = ""  
window(gWindowName).close()  
window(gWindowName).forget()  
end
```

on getNextSample

```
SampleValues = gasFFTobj.getSamples(1,10.)  
return SampleValues  
end
```

on listToField whichList, whichField, whichColumn

```
member(whichField).text = ""  
if whichColumn = VOID then  
repeat with i = 1 to whichList.count  
if i = whichList.count then  
member(whichField).text =member(whichField).text & whichList[i]  
else  
member(whichField).text =member(whichField).text & whichList[i]& RETURN
```

```
    end if
  end repeat
else
  repeat with i = 1 to whichList.count
    if i = whichList.count then
      member(whichField).text =member(whichField).text & whichList[i][whichColumn]
    else
      member(whichField).text =member(whichField).text & whichList[i][whichColumn]& RETURN
    end if
  end repeat
end if
end
```

Create Child Agent

-- this is the main parent script which is responsible for all the properties and behaviours of the agents, the monitoring of the audio signal and the MIDI output

property pAgentSize,pAgentSizeProb,pAgentSizeInc,pAgentMoveProb,pAgentMoveInc
property pAgentDirProb,pAgentBlendInc,pAgentBlendProb,pAgentMaxBlend,pAgentColourRange
property pAgentBirthRate,pAgentBinResponse,pAgentResponse,pAgentGraphic
property pAudioLength,pAudioLengthProb,pAudioLengthInc,pAudioVolProb,pAudioPitchMoveProb
property pAudioPitch,pAudioMode,pAudioChannel,pAudioResponseLevel,pAudioLengthDir,pLengthCounter
property pAudioGetData, pAudioMeter, pAudioMeterProb,pAudioSendData,pModeNumber,pPitchDir
property pVol,pVolDir
-- additional ones needed
property pNoteOnOff, pNoteNum
property pSizeDirChange
-- agent parent script, declare properties shared by all handlers in this object.
property pSpriteNumber, pAgentNumber, pSectionNumber, pOldDir, pDir
-- some old stuff
property pStartWidth, pStartHeight,pPosH, pPosV
-- stuff from another handler when it was ported
global gPosH, gPosV, gOldPosH, gOldPosV, gNibCounter, gOldDir,gasFFTobj,sl, sr, st, sb, sheight,swidth
global gAgentCounter, gAgentSNumList
-- agents graphics dialog box globals
global gGraphicSettingDialog, gGraphicDialogPropList, gGraphicDialogItemList
global gGraphicParamList, gGraphicRealPosList
global gGraphicParam, gGraphicList
-- agents audio dialog box globals
global gAudioSettingDialog, gAudioDialogPropList, gAudioDialogItemList
global gAudioParamList, gAudioRealPosList, gRealPos,gModeList,pAudioPitchIncProb
global gAudioParam, gAudioList, gModeNameList,gMeterCounterList
-- shared between graphic and audio dialog
global gAgents, gSections, gCurrentSection, gBigAgentList
-- call new to create a new instance of the object. Return me returns the reference (or name)
-- of the object to the handler making the "new" call.

on new me, mySpriteNumber, myAgentNumber, mySectionNumber

```
pSpriteNumber=mySpriteNumber -- passed in, used in other handles
pAgentNumber=myAgentNumber
pSectionNumber=mySectionNumber
loadAgentProperties -- assign values from dialog box to agent parameters initi
initialiseAgentPosition -- give agent starting position based on last new agent
return me
end
```

on stepframe me

```
checkAudioInput -- get fft and assign new value to reponse parameter
checkSize
checkInkAndColour-- assign new parameters to agent
checkMove -- see if move is needed
checkBlend -- see if blend change is needed

checkAudioResponse
end
```

on checkAudioResponse

```
-- store graphical data from choosen parameter
case pAudioGetData of
  1: --"Graphic Data Display "
  2: newValue = pAgentSize
  3: newValue = pAgentSizeProb
  4: newValue = pAgentSizeInc
  5: newValue = pAgentMoveProb
  6: newValue = pAgentMoveInc
  7: newValue = pAgentDirProb
  8: newValue = pAgentBlendInc
  9: newValue = pAgentBlendProb
  10: newValue = pAgentMaxBlend
  11: newValue = pAgentColourRange
  12: newValue = pAgentBirthRate
```

```

13:newValue = pAgentBinResponse
14:newValue = pAgentResponse
15:--"graphicsFile  "
16:--"saveFile    "
17:--"loadFile    "
end case

newValue=newValue*2
if random(100)<pAudioResponseLevel then
  if newValue <>0 then
    -- send graphical data to sound parameter
    case pAudioSendData of
      1: --"Graphic Data Display  "
      2: pAudioLength    = newValue
      3: pAudioLengthProb = newValue
      4: pAudioLengthInc = newValue
      5: pAudioVolProb   = newValue
      6:
        if random(100)>40 then
          pPitchDir=-pPitchDir
        end if
        if pNoteNum+pAudioPitch+pPitchDir<120 and pNoteNum+pAudioPitch+pPitchDir>20 then
          pAudioPitch=pAudioPitch+pPitchDir
        end if
      7: pAudioPitchMoveProb = newValue
      8: pAudioPitchIncProb = newValue
      9: pAudioMode         = newValue
      10:pAudioChannel      = newValue
      11:pAudioMeter        = newValue
      12:pAudioMeterProb    = newValue
      13:pAudioMeterDirProb = newValue
      14:pAudioResponseLevel = newValue
      15:--"graphicsFile  "
      16:--"saveFile    "
      17:--"loadFile    "
    end case
  end if
end if

```

```

    end if
end if
--check whether to change volume
if random(100)<pAudioVolProb then
    --check whether to change direction of volume
    if random(100)<(100-pAudioVolProb) then
        pVolDir=-pVolDir
    end if
    pVol = pVol+pVolDir
end if

-- decide length of note
if random(100)<pAudioLengthProb then
    --check direction of movement
    if random(100) < (100-pAudioLengthProb)then
        pAudioLengthDir=-pAudioLengthDir
    end if
    if (pAudioLength + (random(pAudioLengthInc)*pAudioLengthDir))>0 then
        pAudioLength = pAudioLength + (random(pAudioLengthInc)*pAudioLengthDir)
    end if

end if

-- decide to play and which note
if pNoteOnOff="off" then
    -- check note length
    if pLengthCounter>pAudioLength then
        sendMidi("off",pNoteNum,pVol,pAudioChannel)
        pNoteOnOff = "on"
        pLengthCounter=0
    else
        pLengthCounter=pLengthCounter+1
    end if
else
    --check to see if pitch has changed
    if random(100)<pAudioPitchMoveProb then

```

```

    pNoteNum = gModeList[pModeNumber][random(gModeList[pModeNumber].count)]
end if
-- check to see if meter needs distorting
if pAudioMeterProb>0 then
    --check whether to move + or - from meter
    if random(100)<(pAudioMeterProb) then
        pAudioMeter= pAudioMeter+random(pAudioMeterProb)
    else
        pAudioMeter= pAudioMeter-random(pAudioMeterProb)
    end if
end if
-- check meter to see if note should be played
if gMeterCounterList[pAgentNumber] mod (101-pAudioMeter) = 0 then
    pNoteNum=pNoteNum+pAudioPitch
    sendMidi("on",pNoteNum,pVol,pAudioChannel)
    pNoteOnOff = "off"
    if gMeterCounterList[pAgentNumber] >= 100 then
        gMeterCounterList[pAgentNumber]=0
    end if
end if
end if
end

```

on checkInkAndColour

```

    sprite(pSpriteNumber).trails = false
    if pAgentColourRange >= 1 then
        sprite(pSpriteNumber).color = rgb(random(pAgentColourRange), random(pAgentColourRange), random(pAgentColourRange))
    end if
    sprite(pSpriteNumber).ink = 36 --is background transparentpAgentInk
end

```

on checkSize

```

    if random(100) < pAgentSizeProb then
        if random(100)< 20 then

```

```

if pSizeDirChange = "grow" then
  pSizeDirChange = "shrink"
else
  pSizeDirChange = "grow"
end if
end if
if pSizeDirChange = "grow" then
  sprite(pSpriteNumber).width = sprite(pSpriteNumber).width+ pAgentSizeInc
  sprite(pSpriteNumber).height = sprite(pSpriteNumber).height+pAgentSizeInc
else
  sprite(pSpriteNumber).width = sprite(pSpriteNumber).width- pAgentSizeInc
  sprite(pSpriteNumber).height = sprite(pSpriteNumber).height-pAgentSizeInc
end if
end if
end

```

on initialiseAgentPosition

```

if random(100) < pAgentMoveProb then
  --keep it on the screen
  if gPosH[pAgentNumber] > swidth then
    gPosH[pAgentNumber] = 0
  else if gPosH[pAgentNumber] < 0 then
    gPosH[pAgentNumber] = swidth
  end if
  if gPosV[pAgentNumber] > sheight then
    gPosV[pAgentNumber] = 0
  else if gPosV[pAgentNumber] < 0 then
    gPosV[pAgentNumber] = sheight
  end if

  if random(100)<pAgentDirProb then
    pDir = random(8)
  end if

```

```

case pDir of
  1:gPosH[pAgentNumber] = gPosH[pAgentNumber] - pAgentMoveInc
  2:gPosV[pAgentNumber] = gPosV[pAgentNumber] + pAgentMoveInc
  gPosH[pAgentNumber] = gPosH[pAgentNumber] - pAgentMoveInc
  3:gPosV[pAgentNumber] = gPosV[pAgentNumber] + pAgentMoveInc
  4:gPosV[pAgentNumber] = gPosV[pAgentNumber] + pAgentMoveInc
  gPosH[pAgentNumber] = gPosH[pAgentNumber] + pAgentMoveInc
  5:gPosH[pAgentNumber] = gPosH[pAgentNumber] + pAgentMoveInc
  6:gPosV[pAgentNumber] = gPosV[pAgentNumber] - pAgentMoveInc
  gPosH[pAgentNumber] = gPosH[pAgentNumber] + pAgentMoveInc
  7:gPosV[pAgentNumber] = gPosV[pAgentNumber] - pAgentMoveInc
  8:gPosH[pAgentNumber] = gPosH[pAgentNumber] - pAgentMoveInc
  gPosV[pAgentNumber] = gPosV[pAgentNumber] - pAgentMoveInc
end case
end if
pPosH=gPosH[pAgentNumber] --global (needs to be passed from a list)
pPosV=gPosV[pAgentNumber] --global (needs to be passed from a list)

```

```

-- the things below only need to be set once
sprite(pSpriteNumber).visible = true
sprite(pSpriteNumber).puppet = true
sprite(pSpriteNumber).moveableSprite = true
sprite(pSpriteNumber).locV=pPosV
sprite(pSpriteNumber).locH=pPosH
sprite(pSpriteNumber).blend = pAgentMaxBlend
sprite(pSpriteNumber).height = pAgentSize
sprite(pSpriteNumber).width = pAgentSize
sprite(pSpriteNumber).moveableSprite = TRUE
pTimeLapsed=10
pNoteOnOff = "off"
pSizeDirChange="grow"

```

```

end

```

on checkAudioInput

```
if not objectp(gasFFTobj) then return
SampleValues = gasFFTobj.getSamples(10,1,0)
FFTValues = gasFFTobj.getFFT(100,0,TRUE,TRUE) -- two trues mean the bins get equalised down to 10

if FFTValues = 0 or FFTValues = [] then
  put "FFT error reading values:"&gasFFTobj.getError()
else
  maxBin = FFTValues.max()
  repeat with i = 1 to FFTValues.count
    if FFTValues[i] = maxBin then
      highBin=i
    end if
  end repeat
  if pAgentBinResponse=highBin then
    newValue=FFTValues[pAgentBinResponse]
    newValue=integer(newValue)
  else
    newValue=0
  end if

  case pAgentResponse of
    1: --"Graphic Data Display "
    2: --pAgentSize
      pAgentSize = newValue
    3: --pAgentSizeProb
      pAgentSizeProb = newValue
    4: --pAgentSizeInc
      pAgentSizeInc = newValue
    5: --pAgentMoveProb
      pAgentMoveProb = newValue
    6: --pAgentMoveInc
      pAgentMoveInc = newValue
    7: --pAgentDirProb
      pAgentDirProb = newValue
```

```

8: --pAgentBlendInc
  pAgentBlendInc = newValue
9: --pAgentBlendProb
  pAgentBlendProb = newValue
10: --pAgentMaxBlend
  pAgentMaxBlend = newValue
11: --pAgentColourRange
  pAgentColourRange = newValue
12: --pAgentBirthRate
  pAgentBirthRate = newValue
13: --pAgentBinResponse
  pAgentBinResponse = newValue
14: --pAgentResponse
  pAgentResponse = newValue
15: --"graphicsFile"
16: --"saveFile"
17: --"loadFile"
end case
end if
end

```

on checkMove

```

if random(100) < pAgentMoveProb then
  --keep it on the screen
  if pPosH > swidth then
    pPosH = 0
  else if pPosH < 0 then
    pPosH = swidth
  end if
  if pPosV > sheight then
    pPosV = 0
  else if pPosV < 0 then
    pPosV = sheight
  end if
end if

```



```
if random(100)<pAgentDirProb then
  pDir = random(8)
end if
```

```
case pDir of
```

```
  1:pPosH = pPosH - pAgentMoveInc
```

```
  2:pPosH = pPosH - pAgentMoveInc
  pPosV = pPosV + pAgentMoveInc
```

```
  3:pPosV = pPosV + pAgentMoveInc
```

```
  4:pPosH = pPosH + pAgentMoveInc
  pPosV = pPosV + pAgentMoveInc
```

```
  5:pPosH = pPosH + pAgentMoveInc
```

```
  6:pPosH = pPosH + pAgentMoveInc
  pPosV = pPosV - pAgentMoveInc
```

```
  7:pPosV = pPosV - pAgentMoveInc
```

```
  8:pPosH = pPosH - pAgentMoveInc
  pPosV = pPosV - pAgentMoveInc
```

```
end case
```

```
sprite(pSpriteNumber).locV=pPosV
```

```
sprite(pSpriteNumber).locH=pPosH
```

```
end if
```

```
end makeMove
```

on checkBlend

```
if random(100)<pAgentBlendProb then
```

```
  if sprite(pSpriteNumber).blend - pAgentBlendInc < 1 then
```

```
    sendMidi("off",pNoteNum,127,pAudioChannel)
```

```

the actorlist[pSpriteNumber]=VOID
sprite(pSpriteNumber),member=VOID
else
  sprite(pSpriteNumber).blend = sprite(pSpriteNumber).blend - pAgentBlendInc
end if
end if
end changeBlend
on loadAgentProperties
  pos = pAgentNumber
  repeat with i = 1 to gGraphicParam
    case i of
      1: --"Graphic Data Display "
      2: pAgentSize      = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      3: pAgentSizeProb  = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      4: pAgentSizeInc   = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      5: pAgentMoveProb  = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      6: pAgentMoveInc   = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      7: pAgentDirProb   = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      8: pAgentBlendInc  = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      9: pAgentBlendProb = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      10: pAgentMaxBlend = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      11: pAgentColourRange = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      12: pAgentBirthRate = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      13: pAgentBinResponse = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      14: pAgentResponse = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      15: pAgentGraphic  = gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][pos].value].value
      16: --"saveFile "
      17: --"loadFile "
    end case
    pos = pos+gAgents
  end repeat
  truncGraphicName = pAgentGraphic.char[1..pAgentGraphic.length-4]
  memberCheck = member(member(truncGraphicName,"graphics"),.number)
  if memberCheck = -1 then
    db "Sorry, "&member(pAgentGraphic.char[1..pAgentGraphic.length-4],"graphics")&" member doesn't exist."
    repeat with i = 1 to the number of members of castLib("graphics")

```

```

    db "Cast member" && i && "is a" && member(i, "graphics").name
end repeat
else
    sprite(pSpriteNumber).member = member(pAgentGraphic.char[1..pAgentGraphic.length-4], "graphics")
end if
pos = pAgentNumber
repeat with i = 1 to gAudioParam
    case i of
        1: --"Audio Data Display "
        2: pAudioLength      = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        3: pAudioLengthProb = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        4: pAudioLengthInc  = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        5: pAudioVolProb    = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        6: pAudioPitch      = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value+20
        7: pAudioPitchMoveProb = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        8: pAudioPitchIncProb = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        9: pAudioMode       = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        10: pAudioChannel   = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        11: pAudioMeter     = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        12: pAudioMeterProb = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        13: pAudioSendData  = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        14: pAudioResponseLevel = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        15: pAudioGetData   = gBigAgentList[5][gCurrentSection][gBigAgentList[6][gCurrentSection][pos].value].value
        16: --"saveFile "
        17: --"loadFile "
    end case
    pos = pos+gAgents
end repeat

-- changes graphic response parameter name to a number
repeat with i = 1 to gGraphicParamList.count()
    if pAgentResponse = gGraphicParamList[i] then
        pAgentResponse = i
        exit repeat
    end if
end repeat

```

```

-- changes audio graphic response parameter name to a number
repeat with i = 1 to gGraphicParamList.count()
  if pAudioGetData = gGraphicParamList[i] then
    pAudioGetData = i
  exit repeat
end if
end repeat
repeat with i = 1 to gAudioParamList.count()
  if pAudioSendData = gAudioParamList[i] then
    pAudioSendData = i
  exit repeat
end if
end repeat
-- changes mode name to a number
repeat with i = 1 to gModeNameList.count()
  if gModeNameList[i]=pAudioMode then
    pModeNumber = i
  end if
end repeat

pAudioLengthDir = 1
pLengthCounter=0
pVol = 80
pVolDir=1
pNoteNum=gModeList[pModeNumber][random(gModeList[pModeNumber].count)]
pPitchDir=1

end loadAgentProperties
on checkMe meNum, meData
  if pSpriteNumber = meNum then
    db "Sprite:" & pSpriteNumber & " - " & meData
  end if
end
end

```

Timer Script

--this parent script controls the birthrate of the child agents, it is called from a list of timer objects
property pWhichAgent,pWhichSprite,pWhichSection
global gMeterCounterList

on new me, myAgentNum, mySectionNum

```
pWhichAgent=myAgentNum  
pWhichSection=mySectionNum  
return me  
end
```

on calledByTimer me

```
pWhichSprite = findAgentSpace()  
gMeterCounterList[pWhichAgent]=gMeterCounterList[pWhichAgent]+1  
the actorList[pWhichSprite] = new(script"createChildAgent",pWhichSprite, pWhichAgent, pWhichSection)  
  
end  
-- finds a space for a agent in the actorlist
```

on findAgentSpace

```
IWhichSprite = 2 --WAS 1  
foundspace =FALSE  
repeat with i = the actorList.count down to 2 --WAS 1  
  if the actorList[i] = VOID then  
    (the actorList).deleteAt(i)  
  else  
    exit repeat  
  end if  
end repeat  
repeat while foundspace = FALSE  
  if IWhichSprite <= the actorList.count() then  
    if the actorList[IWhichSprite] = VOID then
```

```
    foundspace = TRUE
  else
    IWhichSprite = IWhichSprite + 1
  end if
else
  foundspace = TRUE
end if
end repeat
return IWhichSprite
end
```

Report Back

– handlers in this script process input into the fields of the controller window

```
global gSectionChoice, gSectionName, gAgentChoice, gAgentGraphicName, gAgentAudioName
global gAgentGraphicList, gAgentAudioList, gSectionPath, gGraphicParam, gSections, gSectionDuration
global gAgents, gWindowName, gSectionFileName, gCurrentSection
property pThisField
```

on mouseUp

```
pThisField = sprite(the clickOn).member
case pThisField.name of
"sectionList" :
    gCurrentSection = the mouseLine
    loadAllSectionData gCurrentSection
"AgentGraphicList" :
    gAgentChoice = the mouseLine
    gAgentGraphicName=pThisField.line[gAgentChoice]
    gAgentAudioName=member("agentAudioList").line[gAgentChoice]
    pThisField.line[gAgentChoice].hilite()
    member("agentAudioList").line[gAgentChoice].hilite()
"durationList":
    gCurrentSection = the mouseLine
    loadAllSectionData gCurrentSection
end case
end
```

on keyUp

```
if pThisField = VOID then
    the keyboardFocusSprite = 4
    pThisField = sprite(4).member
end if

case pThisField.name of
"sectionList" :
```

```

-- change section
"AgentGraphicList" :
-- change agent!
"durationList":
-- change duration
--keycode 125 is down and 124 is up
if the keycode=125 then
  if gCurrentSection < pThisField.lines.count then
    gCurrentSection = gCurrentSection + 1
    loadAllSectionData gCurrentSection
  else
    gCurrentSection = 1
    loadAllSectionData gCurrentSection
  end if
else if the keycode = 126 then
  if gCurrentSection > 1 then
    gCurrentSection = gCurrentSection - 1
    loadAllSectionData gCurrentSection
  else
    gCurrentSection= pThisField.lines.count
    loadAllSectionData gCurrentSection
  end if
end if
if the Key = RETURN then
  delete pThisField.line[gCurrentSection+1]
  loadAllSectionData gCurrentSection
end if

end case
end keyUp

```


Button

-- these handlers control the button functionality

global **gAgentTimerList,gPlayingSection,gPlayingPerformance,gSectionChoice, gCDROM**

on mouseEnter me

```
sprite(the currentSpriteNum).foreColor = 18
```

```
case the frameLabel of
```

```
"s1": -- scene 1 buttons
```

```
case the currentSpriteNum of
```

```
10: show = "No Performance Open"
```

```
11: show = "No Performance Open"
```

```
12: show = "No Performance Open"
```

```
13: show = "No Performance Open"
```

```
14: show = "Open Performance"
```

```
15: show = "No Performance Open"
```

```
16: show = "No Performance Open"
```

```
17: show = "Midi Shut Up"
```

```
otherwise
```

```
show = "BUTTON NOT ACTIVE"
```

```
end case
```

```
"s2": -- scene 2 buttons
```

```
case the currentSpriteNum of
```

```
10: show = "Section Configuration"
```

```
11: show = "Graphic Configuration"
```

```
12: show = "Audio Configuration"
```

```
13:
```

```
if the windowlist.count = 0 or (the windowlist.count=1 and gCDROM = TRUE) then
```

```
show = "Start Performance"
```

```
else if gPlayingPerformance = FALSE then
```

```
show = "Play Performance"
```

```
else
```

```
show = "Stop Performance"
```

```

end if
14: show = "Open Performance"
15: show = "Save Performance"
if the windowlist.count=0 or (the windowlist.count=1 and gCDROM = TRUE) then
  show = "Start Section "&gSectionChoice
else if gPlayingSection = FALSE then
  show = "Play Section "&gSectionChoice
else
  show = "Stop Section "&gSectionChoice
end if
17: show = "Midi Shut Up"
otherwise
  show = "BUTTON NOT ACTIVE"
end case
"s3": -- scene 3 buttons
case the currentSpriteNum of
  10: show = "scene 3 button 1"
  11: show = "scene 3 button 2"
  12: show = "scene 3 button 3"
  13: show = "scene 3 button 4"
  14: show = "scene 3 button 3"
  15: show = "scene 3 button 4"
  17: show = "Midi Shut Up"
otherwise
  show = "BUTTON NOT ACTIVE"
end case
"s4": -- scene 4 buttons
case the currentSpriteNum of
  10: show = "scene 4 button 1"
  11: show = "scene 4 button 2"
  12: show = "scene 4 button 3"
  13: show = "scene 4 button 4"
  14: show = "scene 3 button 3"
  15: show = "scene 3 button 4"
  17: show = "Midi Shut Up"
otherwise

```

```

    show = "BUTTON NOT ACTIVE"
  end case
  otherwise
    show = "SCENE NOT ACTIVE"
  end case
  member("display1").text = show
end mouseEnter

```

on mouseLeave

```

  sprite(the currentSpriteNum).foreColor = 2
  member("display1").text = ""
end
on mouseUp me
  case the frameLabel of
    "s1": -- scene 1 buttons
      case the currentSpriteNum of
        10: --callDialogBox 1
        11: --callDialogBox 2
        12: --callDialogBox 3
        13: --getReadyToRumble
        14: go "s2"
      openPerformance
        15: --savePerformance
        17: show = "Midi Shut Up"
      otherwise
        show = "BUTTON NOT ACTIVE"
      end case
    "s2": -- scene 2 buttons
      case the currentSpriteNum of
        10: callDialogBox 1
        11: callDialogBox 2
        12: callDialogBox 3
        13: getReadyToRumble("performance")
        14: go "s2"
      openPerformance

```

```
15: savePerformance
16: getReadyToRumble("section")
17: midiShutUp
otherwise
  show = "BUTTON NOT ACTIVE"
end case
"s3": -- scene 3 buttons
case the currentSpriteNum of
  14: go "s2"
  openPerformance
  15: savePerformance
  17: midiShutUp
  otherwise
    show = "BUTTON NOT ACTIVE"
  end case
"s4": -- scene 4 buttons
case the currentSpriteNum of
  10:
  11:
  12:
  13:
  14: go "s2"
  openPerformance
  15: savePerformance
  17: midiShutUp
  otherwise
    show = "BUTTON NOT ACTIVE"
  end case
otherwise
  show = "SCENE NOT ACTIVE"
end case
end
```

MIDI

-- This script contains handlers configures the MIDI xtra and has handlers to send and receive MIDI data.

```
global gMIDIioXtra
global gInPorts, gOutPorts
global gInputPort, gOutputPort
global gInChan, gOutChan
global gNotesDown
```

on midiShutUp

```
repeat with z= 1 to 16
  repeat with j = 1 to 10
    repeat with i = 1 to 200
      sendMidi("off",i,0,z)
    end repeat
  end repeat
end repeat
end
```

on sendMidi onoff, noteNum, vol, chanNum

```
if onoff="on" then
  SendMessage( gMIDIioXtra, [#noteOn, chanNum, noteNum, vol] )
else
  SendMessage( gMIDIioXtra, [#noteOff, chanNum, noteNum, vol] )
end if
end
```

on SelectInputPort num

```
CloseInput( gMIDIioXtra )
err = OpenInput( gMIDIioXtra, num, 32768 )
put "OpenInput returned: " & getProp( err, #text )
gInputPort = num
end
```

on SelectInputChannel num

```
SetChannelFilter( gMIDIioXtra, [], 0 ) --reset filter state
SetChannelFilter( gMIDIioXtra, [#note], num ) --receive note messages only
gInChan = num
end
```

on SelectOutputPort num

```
CloseOutput( gMIDIioXtra )
set err to OpenOutput( gMIDIioXtra, num )
put "OpenOutput returned: " & getProp( err, #text )

set gOutputPort to num
end
```

on SelectOutputChannel num

```
set gOutChan to num
end
```

on getMidi

```
repeat while MessagesPending( gMIDIioXtra )
  set msg to GetMessage( gMIDIioXtra )
  put msg --uncomment this to see all messages in the message window

  set type to getProp( msg, #type ) --could be msg.type in D7
  if type = #noteOn or type = #noteOff then

    if type = #noteOn then
      KeyboardNoteOn( getProp( msg, #number ) )
    else if type = #noteOff then
      KeyboardNoteOff( getProp( msg, #number ) )
    end if

    setProp( msg, #number, getProp( msg, #number ) + 7 ) --transpose up a 5th
    setProp( msg, #channel, gOutChan ) --reroute to output channel
  end repeat
```

```
set err to SendMessage( gMIDIIOExtra, msg )
if getProp( err, #code ) <> 0 then
    put "MIDIIO Error: " & getProp( err, #text )
end if

end if
end repeat
end
```

Initialise Everything

```
--this script initialises all global variables, xtras and paths
--graphics globals
global gChildList    -- A list to hold the child object references.
global gWhichSprite  -- Counts the number of sprites
global gAgentSettings -- list to hold current agent setting to seed new child agents
global sl, sr, st, sb, sheight,swidth, gPosH, gPosV,gOldPosV,gOldPosH, gAgentCounter, gAgentSNumList
--fft globals
global gFFTCounter, gasFFTobj, gSampleValues, gFFTValues
--midi globals
global gMIDIioXtra
-- agents graphics dialog box globals
global gGraphicSettingDialog, gGraphicDialogPropList, gGraphicDialogItemList, gBigAgentList
global gGraphicParamList, gGraphicRealPosList,gGraphicsFilePath
global gGraphicParam, gGraphicList,gGraphicFileList
-- agents audio dialog box globals
global gAudioSettingDialog, gAudioDialogPropList, gAudioDialogItemList
global gAudioParamList, gAudioRealPosList, gRealPos,gAudioSettingPath
global gAudioParam, gAudioList,gAudioFilePath,gModeNameList,gModeList
-- shared between graphic and audio dialog
global gSections, gAgentAudioList,gAgentTimerList,gAgentTimerScripts, gOpenDialog
-- PERFORMANCE PARAMETERS
global gWindowName -- MIAW globals
global gAgents, gSectionChoice, gNumOfSections, gWhichScript, gDurationList, gSectionList, gPerformanceName
global gPerformParam,gPerformParamList,gGraphicsSettingPath,gSectionPath,gGraphicProfilePath,gAudioProfilePath
global gTotalTime, gPerformanceMovie
-- performance globals
global gMasterSeconds,gMasterMinutes,gPerformanceTimer,gDisplayTimer,gPlayingSection,gCurrentSection,gDebugMode
global gCDROM,gPlayingPerformance,gMeterCounterList
```

on initialiseGlobals

```
gBigAgentList = [[]]
gOpenDialog = [FALSE,FALSE,FALSE]
```



```

--gBigAgentList.append([])
gCurrentSection=1
gAgentCounter=0
gAgentSNumList=[]
the keyDownScript= "checkKey"
gWhichSprite = 1
gChildList = [:]
gAgentSettings = []
gPosH = []
gPosV = []
gOldPosH=[]
gOldPosV=[]
gGraphicFileList=[]
gFFTCounter=1
gAgentTimerList=[]
gAgentTimerScripts=[]
gDurationList=[]
gModeNameList=[]
gPlayingSection=FALSE
gPlayingPerformance=FALSE
-- setup dialog box with cols(agents),rows(parameters) and sections
-- rows needs to include label row and value display row
gAgents = 8 -- this is here for stand alone performance, i.e. no controller
gGraphicParamList = []
gGraphicRealPosList = []
gGraphicParam = 17
gAudioParamList = []
gAudioRealPosList = []
gAgentAudioList=[]
gAudioParam = 17
gSections = 3 -- start group, row and end group
gTotalTime=0
gMeterCounterList=[]

repeat with i = 1 to gAgents
  gMeterCounterList.append(0)

```

```

end repeat

if the windowlist.count=1 then
  gCDROM=TRUE
  db "CDROM version"
else
  gCDROM = false
  db "non-CDROM version"
end if
-- load parameter names, should be in sync with default.txt files and createAgent parent script
repeat with i = 1 to gGraphicParam
  case i of
    1: gGraphicParamList.append("Data Display")
    2: gGraphicParamList.append("Size ")
    3: gGraphicParamList.append("SizeProb ")
    4: gGraphicParamList.append("SizeInc ")
    5: gGraphicParamList.append("MoveProb ")
    6: gGraphicParamList.append("MoveInc ")
    7: gGraphicParamList.append("DirProb ")
    8: gGraphicParamList.append("BlendInc ")
    9: gGraphicParamList.append("BlendProb ")
    10: gGraphicParamList.append("MaxBlend ")
    11: gGraphicParamList.append("ColourRange ")
    12: gGraphicParamList.append("BirthRate ")
    13: gGraphicParamList.append("BinResponse ")
    14: gGraphicParamList.append("Respond to ")
    15: gGraphicParamList.append("GraphicsFile")
    16: gGraphicParamList.append("SaveFile ")
    17: gGraphicParamList.append("LoadFile ")
  end case
end repeat

repeat with i = 1 to gAudioParam
  case i of
    1: gAudioParamList.append("Data Display ")
    2: gAudioParamList.append("Length ")

```

```

3: gAudioParamList.append("LenghtProb ")
4: gAudioParamList.append("LengthInc ")
5: gAudioParamList.append("VolumeProb ")
6: gAudioParamList.append("Pitch ")
7: gAudioParamList.append("PitchMoveProb")
8: gAudioParamList.append("PitchIncProb ")
9: gAudioParamList.append("Cluster ")
10: gAudioParamList.append("Channel ")
11: gAudioParamList.append("Meter ")
12: gAudioParamList.append("MeterProb ")
13: gAudioParamList.append("ResponceParam")
14: gAudioParamList.append("ResponceLevel")
15: gAudioParamList.append("RespondTo ")
16: gAudioParamList.append("SaveFile ")
17: gAudioParamList.append("LoadFile ")
end case
end repeat
--load names of modes
repeat with i = 1 to 10
case i of
1: gModeNameList.append("Harvey-----")
2: gModeNameList.append("Maidley----")
3: gModeNameList.append("Reaney-----")
4: gModeNameList.append("Hunter-----")
5: gModeNameList.append("Grey-----")
6: gModeNameList.append("Lorimer----")
7: gModeNameList.append("Jones-----")
8: gModeNameList.append("Bremner-----")
9: gModeNameList.append("Charlton----")
10: gModeNameList.append("Clark-----")
end case
end repeat
gModeList =[]
repeat with i = 1 to 10
case i of
1:gModeList.append([1])

```

```

2:gModeList.append([1,6,8])
3:gModeList.append([1,5,8,12])
4:gModeList.append([1,4,7,10])
5:gModeList.append([1,6,11,16,21])
6:gModeList.append([1,3,5,6,8,10,12])
7:gModeList.append([1,3,5,7,9,11])
8:gModeList.append([1,2,4,5,7,8,10,11])
9:gModeList.append([1,2,3,5,6,7,9,10,11])
10:gModeList.append([1,2,3,4,5,6,7,8,9,10,11,12])
end case
end repeat
-- initialise starting positions for graphic
if gCDROM = TRUE then
  sr = 500
  sl = 0
  st = 0
  sb = 330
else
  sr = 1024 -- the stageRight
  sl = 0 --the stageLeft
  st = 0 --the stageTop
  sb = 768 --the stageBottom
end if

sheight = sb - st
swidth = sr - sl
repeat with i = 1 to gAgents
  gPosH.append(random(swidth))
  gPosV.append(random(sheight))
  gOldPosV.append(0)
  gOldPosH.append(0)
  gAgentAudioList.append("no sound")
end repeat
end
on db message, priority

```

```
if gDebugMode = 1 then
  put message
else if gDebugMode = 2 then
  alert message
else if gDebugMode = 3 and priority = 1 then
  alert message
end if
end
```

on initialisePaths

```
gGraphicsSettingPath=the moviepath&"agentProfiles\graphicProfile\GraphicDefault"
gAudioSettingPath=the moviepath&"agentProfiles\audioProfile\AudioDefault"
gGraphicProfilePath="agentProfiles\graphicProfile"
gAudioProfilePath="agentProfiles\audioProfile"
gGraphicsFilePath="graphics"
gAudioFilePath="audio"
gPerformanceSettingFileList=the moviepath&"performances\PerformanceDefault"
gSectionPath="sections\"
gWindowName="performance1"
```

end

on initialiseController

```
-- PERFORMANCE PARAMETERS
gMasterSeconds = 0
gMasterMinutes = 0
gPerformanceParam=4
gPerformanceParamList=[]
gAgents = 1
gPerformanceParamNum = 1
gNumOfSections = 1
gDurationList = []
gSectionList = []
gPerformanceRealPosList = []
```

```

gPerformanceList = []
repeat with i = 1 to 7 --gPerformanceParam
  case i of
    1: gPerformanceParamList.append("Title   :")
    2: gPerformanceParamList.append("Section :")
    3: gPerformanceParamList.append("Duration :")
    4: gPerformanceParamList.append("FileName :")
    5: gPerformanceParamList.append("Data Display :")
    6: gPerformanceParamList.append("Open File :")
    7: gPerformanceParamList.append("Save File :")
  end case
end repeat

end

```

on initialiseXtras

```

-- initialise MIDI
if Not objectP( gMIDIioXtra ) then
  openXLib "MIDIio"
  gMIDIioXtra = New( xtra "MIDIio" )
  Register( gMIDIioXtra, "Tim Sayer", "MIX100-01064-31326-557075-07" )
  Init( gMIDIioXtra )
  if Not objectP( gMIDIioXtra ) then
    db "MIDIio xtra failed"
  else
    db "MIDIio xtra created"
  end if
else
  db "MIDIio xtra already exists"
end if
gInPorts = GetInputPorts( gMIDIioXtra )
SelectInputPort(1)
SelectInputChannel(1)

gOutPorts = GetOutputPorts( gMIDIioXtra )

```

```

db "gInPorts:" & gInPorts
db "gOutPorts:" & gOutPorts

if gOutPorts = [] then
  alert "No MIDI output port has been detected, this application will not function correctly"
end if

SelectOutputPort(2)
SelectOutputChannel(1)

-- initialise fft xtra
if Not objectP( gasFFTobj ) then
  gasFFTobj = new(Xtra "asFFT", "Tim Sayer", "01yy5xEIFEHA7rgA62FKJEBFr9tTHsHmAcZ")
  gSampleValues=[]
  gFFTValues=[]
  if Not objectP( gasFFTobj ) then
    db "FFT xtra failed"
  else
    db "FFT xtra created"
  end if
else
  db "FFT xtra already exists"
end if
-- bins 400 and timesmooth 2
gasFFTobj.setParams(400,2)
end

```

on goStart

```

put "Go to start"
Tell gPerformanceMovie to goBackToStart
Tell gPerformanceMovie to stopTimers
cleanUp
getReadyToRumble "performance"
end

```

on startTimers

```
repeat with i = 1 to gAgentTimerList.count
  gAgentTimerList[i].forget()
end repeat

gAgentTimerScripts = []
gAgentTimerList = []
go "s2"
IDurList = []
repeat with i = 1 to gAgents
  IDurList.append(gBigAgentList[2][gCurrentSection][gBigAgentList[3][gCurrentSection][(11*gAgents)+i].value].value)
end repeat

repeat with whichAgent = 1 to gAgents
  gAgentTimerScripts.append(new(script "timerScript", whichAgent, gSectionChoice))
  gAgentTimerList.append(timeout("agentTimer"&whichAgent).new(IDurList[whichAgent], #calledByTimer, gAgentTimerScripts[whichAgent] ))
end repeat
end
on stopTimers
  repeat with i = 1 to gAgentTimerList.count
    gAgentTimerList[i].forget()
  end repeat

  gAgentTimerScripts = []
  gAgentTimerList = []
  the actorlist = []
end
```

on SearchAndReplace input, stringToFind, stringToInsert

```
output = ""
findLen = stringToFind.length - 1
repeat while input contains stringToFind
  currOffset = offset(stringToFind, input)
```



```
output = output & input.char [1..currOffset]
delete the last char of output
output = output & stringToInsert
delete input.char [1.. (currOffset + findLen)]
end repeat
set output = output & input
return output
end
```

on getfiles whichDir

```
fileList = [ ]
whichPath = the moviePath&whichDir
repeat with i = 1 to 100
  n = getNthFileNameInFolder(whichDir, i)
  if n = EMPTY then exit repeat
  fileList.append(n)
end repeat
return fileList
end
```

on searchFile whichFile, whichDir

```
found=FALSE
repeat with i = 1 to 100
  n = getNthFileNameInFolder(whichDir, i)
  if n = whichFile then
    found=TRUE
    exit repeat
  end if
end repeat
return found
end
```

on cleanUp

```
the actorList = []
```

```

repeat with i = 1 to gAgentTimerList.count
  gAgentTimerList[i].forget()
end repeat
gAgentTimerScripts=[]
gAgentTimerList=[]
gMasterSeconds=0
gMasterMinutes=0
gPlayingSection=FALSE
if gDisplayTimer <> VOID then
  gDisplayTimer.forget()
end if

member("Time").text = "Time Remaining - 0:0"
midiShutUp
if the windowlist <> [] then
  window(gWindowName).close()
  window(gWindowName).forget()
end if
end

```

on cleanUpCasts

```

repeat with i = 1 to the number of members of castLib("graphics")
  member(i,"graphics").erase()
end repeat
repeat with i = 1 to the number of members of castLib("audio")
  member(i,"audio").erase()
end repeat
end
on cleanUpXtras
if objectP( gMIDIioXtra ) then
  midiShutUp
  set gMIDIioXtra to 0
  closeXLib "MIDIio"
end if
if objectP(gasFFTobj) then

```

```
    set gasFFToj to 0
end if
if objectP(gGraphicSettingDialog) then
    set gGraphicSettingDialog to 0
end if
if objectP(gAudioSettingDialog) then
    set gAudioSettingDialog to 0
end if
end
```

on killGlobals

```
gChildList=VOID
gWhichSprite=VOID
gAgentSettings=VOID
sl=VOID
sr=VOID
st=VOID
sb=VOID
sheight=VOID
swidth=VOID
gPosH=VOID
gPosV=VOID
gOldPosV=VOID
gOldPosH=VOID
gAgentCounter=VOID
gAgentSNumList=VOID
gFFTCOUNTER=VOID
gasFFToj=VOID
gSampleValues=VOID
gFFTValues=VOID
gMIDIioXtra=VOID
gGraphicSettingDialog=VOID
gGraphicDialogPropList=VOID
gGraphicDialogItemList=VOID
gBigAgentList=VOID
```

gGraphicParamList=VOID
gGraphicRealPosList=VOID
gGraphicsFilePath=VOID
gGraphicParam=VOID
gGraphicList=VOID
gGraphicFileList=VOID
gAudioSettingDialog=VOID
gAudioDialogPropList=VOID
gAudioDialogItemList=VOID
gAudioParamList=VOID
gAudioRealPosList=VOID
gRealPos=VOID
gAudioSettingPath=VOID
gAudioParam=VOID
gAudioList=VOID
gAudioFilePath=VOID
gModeNameList=VOID
gModeList=VOID
gSections=VOID
gAgentAudioList=VOID
gAgentTimerList=VOID
gAgentTimerScripts=VOID
gWindowName=VOID
gAgents=VOID
gSectionChoice=VOID
gNumOfSections=VOID
gWhichScript=VOID
gDurationList=VOID
gSectionList=VOID
gPerformanceName=VOID
gPerformParam=VOID
gPerformParamList=VOID
gGraphicsSettingPath=VOID
gSectionPath=VOID
gGraphicProfilePath=VOID
gAudioProfilePath=VOID

```
gTotalTime=VOID  
gPerformanceMovie=VOID  
gMasterSeconds=VOID  
gMasterMinutes=VOID  
gPerformanceTimer=VOID  
gDisplayTimer=VOID  
gPlayingSection=VOID  
gPlayingPerformance=VOID  
gCurrentSection=VOID  
gDebugMode=VOID  
gCDROM=VOID
```

```
end
```

File IO

--this script contains handlers to open, read and save configuration data to text files

-- read file

global **gNewFileName**

on openAndReadText filename

-- create the FileIO instance

fileObj = new(xtra "FileIO")

if filename = "" then

-- set the filter mask to text files

if the platform contains "mac" then

setFilterMask(fileObj, "TEXT")

else

setFilterMask(fileObj, "Text Files, *.txt, All Files, *.*")

end if

-- open dialog box

filename = **displayOpen(fileObj)**

gNewFileName = filename

-- check to see if cancel was hit

if filename = "" then return ""

end if

if filename<> VOID then

-- open the file

openFile(fileObj, filename, 1)

-- check to see if file opened ok

if **status(fileObj)** <> 0 then

err = **error(fileObj, status(fileObj))**

alert "Error:"&&**err**

return ""

end if

```
-- read the file
text = readFile(fileObj)

-- close the file
closeFile(fileObj)

--return the text
return text
end if
end
```

on **getNewFileName**

```
-- create the FileIO instance
fileObj = new(xtra "FileIO")
-- open dialog box
filename = displayOpen(fileObj)
-- close the file
closeFile(fileObj)
--return the filename
return filename
end

-- save file
on saveText text
-- create the FileIO instance
fileObj = new(xtra "FileIO")
-- set the filter mask to text files
if the platform contains "mac" then
  setFilterMask(fileObj, "TEXT")
else
  setFilterMask(fileObj, "Text Files,* .txt,All Files,*.*")
end if
-- save dialog box
filename = displaySave(fileObj, "", "")
-- check to see if cancel was hit
```

```
if filename = "" then return FALSE
-- delete existing file, if any
openFile (fileObj,filename,2)
delete(fileObj)
-- create and open the file
createFile(fileObj,filename)
openFile(fileObj,filename,2)
-- check to see if file opened ok
if status(fileObj) <> 0 then
  err = error(fileObj,status(fileObj))
  alert "Error:"&&err
  return FALSE
end if
-- write the file
writeString(fileObj,text)
-- set the file type
if the platform contains "Mac" then
  setFinderInfo(fileObj, "TEXT txt")
end if
-- close the file
closeFile(fileObj)
return TRUE
end
```


Agent Audio Dialog Box

```
--this script contains handlers to setup the audio dialog box
global gAudioSettingDialog, gAudioDialogPropList, gAudioDialogItemList
global gAudioParamList, gAudioRealPosList, gRealPos, gAgentAudioList
global gAgents, gAudioParam, gSections, gAudioList, gGraphicList, gGraphicParams
global gAudioSettingPath, gAudioFilePath, gSectionName, gAudioProfilePath
global gModeNameList, gGraphicParamList
-- temp globals
global gTxt, gTxt1
```

on agentAudioDialogSetup col, row, sections

```
gAudioSettingDialog = new(xtra "mui")
gAudioDialogPropList = GetWindowPropList(gAudioSettingDialog)
gAudioDialogPropList.name = "Audio:"&gSectionName
gAudioDialogPropList.callback = "theAudioCallBack"
gAudioDialogPropList.width = 200
gAudioDialogPropList.modal = false
gAudioDialogPropList.closeBox = TRUE
gAudioDialogItemList = []
gAudioRealPosList=[]
-- Set up the beginning of the dialog box
templtemPropList = GetItemPropList(gAudioSettingDialog)
templtemPropList.type = #windowBegin
gAudioDialogItemList.append(duplicate(templtemPropList))
gRealPos=1
repeat with i = 1 to row
  repeat with j = 1 to sections
    case j of
      1:-- Set up the beginning of an overall group
        templtemPropList = GetItemPropList(gAudioSettingDialog)
        templtemPropList.type = #groupHBegin
        gAudioDialogItemList.append(duplicate(templtemPropList))
        gRealPos = gRealPos+1
```

```

2:-- puts a row of titles from parameter list
templtemPropList = GetItemPropList(gAudioSettingDialog)
templtemPropList.type = #label
templtemPropList.value = gAudioParamList[i]
templtemPropList.title = "paramLabel" & i
gAudioDialogItemlist.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
-- create columns
repeat with k = 1 to gAgents
  templtemPropList = GetItemPropList(gAudioSettingDialog)
  templtemPropList.title = "P" & i & "A" & k
  gAudioDialogItemlist.append(duplicate(templtemPropList))
  gRealPos=gRealPos+1
  gAudioRealPosList.append(gRealPos)
end repeat
3:-- end group
templtemPropList = GetItemPropList(gAudioSettingDialog)
templtemPropList.type = #groupHEnd
gAudioDialogItemlist.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
end case
end repeat
end repeat
-- Last, set up end of window
templtemPropList = GetItemPropList(gAudioSettingDialog)
templtemPropList.type = #windowEnd
gAudioDialogItemlist.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
--load with default settings
--gAudioList = getfiles(".",\audio")
gAudioList = getfiles(gAudioFilePath)
-- repeat with i = 1 to gAgents
-- loadAudioSettings i, gAudioSettingPath&i&".txt"
-- end repeat
repeat with i = 1 to gAgentAudioList.count
  loadAudioSettings i, gAgentAudioList[i]

```

```
end repeat
```

```
end
```

on importIntoCast whichFiles,whichCast

```
memberList = [ ]  
whichPath = the moviePath&whichCast  
repeat with i = 1 to whichFiles.count()  
  audioFile = whichPath & "\ " & whichFiles[i]  
  importFileInto(member(i,whichCast),audioFile)  
  memberList.append(member(i,whichCast).name)  
end repeat  
return memberList  
end
```

on loadAudioSettings agentNum, defaultfile

```
defaultfile = gAudioProfilePath&"\ "&defaultfile  
gAudioMemberList = importIntoCast( gAudioList, "audio")  
tempAgentData=[]  
tempAgentData = openAndReadText(defaultfile)  
-- this formatting is needed to turn string into a value (list).. don't ask me why, took me a day to find out  
tempAgentData = SearchAndReplace(tempAgentData, "<Void>", "void")  
tempAgentData = value(tempAgentData)  
whichParam = agentNum  
paramCounter = tempAgentData.count  
tempAgentData[1].value = "-A G E N T "&agentNum&"-"  
audioFile = tempAgentData[paramCounter-2].value  
if searchFile(audioFile&".wav",gAudioFilePath) then  
  importFileInto(member(agentNum,"audio"),audioFile&".wav")  
else if searchFile(gAudioFilePath&".mp3",gAudioFilePath) then  
  importFileInto(member(agentNum,"audio"),gAudioFilePath&"\ "&audioFile&".mp3")  
else  
  --put audioFile & " NOT FOUND"
```

```

end if
repeat with i = 1 to paramCounter
  case i of
    9:
      tempAgentData[i].attributes.valueList=gModeNameList
    13:
      tempAgentData[i].attributes.valueList=gAudioParamList
    15:
      tempAgentData[i].attributes.valueList=gGraphicParamList
  end case

  gAudioDialogItemList[gAudioRealPosList[whichParam]]= tempAgentData[i]
  ItemUpdate(gAudioSettingDialog, gAudioRealPosList[whichParam], gAudioDialogItemList[gAudioRealPosList[whichParam]])
  whichParam = whichParam + gAgents
end repeat

end

```

on theAudioCallBack (event, eventData, itemPropList)

```

gAudioDialogItemList[eventData].value = itemPropList.value
if symbolP(event) then -- basic error check
  case event of
    #windowOpening:
    #itemChanged :
      --find which agent had been changed
      foundAt = -1
      repeat with i = 1 to gAudioRealPosList.count
        if gAudioRealPosList[i]=eventData then
          foundAt = i
        end if
      end repeat
      if foundAt = -1 then
        else
          if foundAt mod gAgents = 0 then
            whichAgent = gAgents
          end if
        end if
      end if
    end case
  end if
end if

```

```

else
  whichAgent = foundAt mod gAgents
end if
end if

if itemPropList.type = #IntegerSliderH then
  gAudioDialogItemList[gAudioRealPosList[whichAgent]].value = 01 - - - "& string(itemPropList.value) & " - - - "0
  ItemUpdate(gAudioSettingDialog, gAudioRealPosList[whichAgent], gAudioDialogItemList[gAudioRealPosList[whichAgent]])

else if itemPropList.type = #PopupList then
  -- load Audio into cast member
  if itemPropList.title = "audioList" then
    audioFile = itemPropList.value
    if searchFile(audioFile,gAudioFilePath) then
      importFileInto(member(whichAgent, "audio"),gAudioFilePath&"\"&audioFile)
    else
      --put audioFile & " NOT FOUND"
    end if
  end if
end if

#itemClicked :
foundAt = -1
repeat with i = 1 to gAudioRealPosList.count
  if gAudioRealPosList[i]=eventData then
    foundAt = i
  end if
end repeat
if foundAt = -1 then
  --put"DEBUG: sorry not found on gAudioRealPosList"
else
  if foundAt mod gAgents = 0 then
    whichAgent = gAgents
  else
    whichAgent = foundAt mod gAgents
  end if

```

```

case ( itemPropList.type ) of
  #bitmap : beep
  #defaultPushButton : beep
  #pushButton :
    case itemPropList.title of
      "Save Settings":
        saveAudioSettings whichAgent
      "Load Settings":
        loadAudioSettings whichAgent, ""
      otherwise put "Button " & itemPropList.title & " not recognised"
    end case
  #cancelPushButton : beep
end case
end if
#windowOpening: put "Window Opening"
#windowClosed: put "Window Closed"
#windowZoomed : put "Window Zoomed"
#windowResized :put "Window Resized"
otherwise :
end case
else
  -put "other event occurred"
end if
end

```

on saveAudioSettings agentNum

```

tempAgentData=[]
whichParam = agentNum
aList=gAudioParam-2
repeat with i = 1 to gAudioParam
  case i of
    1: gAudioDialogItemList[gAudioRealPosList[whichParam]].value="Agent "&agentNum
  end case

tempAgentData.append(gAudioDialogItemList[gAudioRealPosList[whichParam]])

```

```
    whichParam = whichParam + gAgents  
end repeat  
tempAgentData=string(tempAgentData )  
saveText tempAgentData  
end
```

Agent Graphics Dialog Box

```
--this script contains handlers to setup the graphics dialog box
global gGraphicSettingDialog,gGraphicDialogItemList,gGraphicDialogPropList,gGraphicRealPosList
--global smileyIndex
global gGraphicParamList, gRealPos,gGraphicsSettingPath
global gAgents, gGraphicParam, gSections, gGraphicList, gAudioList, gDurationList
global gAgentTimerList, gGraphicsFilePath,gGraphicProfilePath
--from reportback
global gSectionChoice, gSectionName, gAgentChoice, gAgentGraphicName, gAgentAudioName
global gAgentGraphicList, gAgentAudioList,gNewFileName,gGraphicFileList,gGraphicMemberList
-- temp globals
--global gTxt, gTxt1
```

on agentGraphicDialogSetup col, row, sections

```
gGraphicSettingDialog = new(xtra "mui")
gGraphicDialogPropList = GetWindowPropList(gGraphicSettingDialog)
gGraphicDialogPropList.name = "Graphics:"&gSectionName
gGraphicDialogPropList.callback = "theGraphicCallBack"
gGraphicDialogPropList.width = 200
gGraphicDialogPropList.modal = false
gGraphicDialogPropList.closeBox = TRUE
gGraphicDialogItemList = []
gGraphicRealPosList = []
-- Set up the beginning of the dialog box
templtemPropList = GetItemPropList(gGraphicSettingDialog)
templtemPropList.type = #windowBegin
gGraphicDialogItemList.append(duplicate(templtemPropList))
gRealPos=1
repeat with i = 1 to row
  repeat with j = 1 to sections
    case j of
      1:-- Set up the beginning of an overall group
        templtemPropList = GetItemPropList(gGraphicSettingDialog)
```



```

templtemPropList.type = #groupHBegin
gGraphicDialogItemList.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
2:-- puts a row of titles from parameter list
templtemPropList = GetItemPropList(gGraphicSettingDialog)
templtemPropList.type = #label
templtemPropList.value = gGraphicParamList[i]
templtemPropList.title = "paramLabel" & i
gGraphicDialogItemList.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
-- create columns
repeat with k = 1 to gAgents
  templtemPropList = GetItemPropList(gGraphicSettingDialog)
  templtemPropList.title = "P" & i & "A" & k
  gGraphicDialogItemList.append(duplicate(templtemPropList))
  gRealPos=gRealPos+1
  gGraphicRealPosList.append(gRealPos)
end repeat
3:-- end group
templtemPropList = GetItemPropList(gGraphicSettingDialog)
templtemPropList.type = #groupHEnd
gGraphicDialogItemList.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
end case
end repeat
end repeat
-- Last, set up end of window
templtemPropList = GetItemPropList(gGraphicSettingDialog)
templtemPropList.type = #windowEnd
gGraphicDialogItemList.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
--load with default settings
gGraphicFileList=[]
repeat with i = 1 to gAgentGraphicList.count
  loadGraphicsSettings i, gAgentGraphicList[i]
end repeat

```

```

end
on loadGraphicsSettings agentNum, defaultfile
  fileNameNoPath = defaultfile
  if defaultfile <> "" then
    defaultfile = gGraphicProfilePath & "\" & defaultfile
  end if
  if gGraphicList = [] then
    alert the moviename & ": No Graphics File"
  else
    tempAgentData = []
    tempAgentData = openAndReadText(defaultfile)
    -- this formatting is needed to turn string into a value (list).. don't ask me why, took me a day to find out
    tempAgentData = SearchAndReplace(tempAgentData, "<Void>", "void")
    tempAgentData = value(tempAgentData)
    whichParam = agentNum
    paramCounter = tempAgentData.count
    tempAgentData[1].value = agentNum & "-" & fileNameNoPath
    tempAgentData[15].attributes.valueList = gGraphicList
    --easier to dump the duration data into a separate list
    gDurationList.append(tempAgentData[12].value)
    repeat with i = 1 to paramCounter
      case i of
        14:
          tempAgentData[i].attributes.valueList = gGraphicParamList
      end case
      gGraphicDialogItemList[gGraphicRealPosList[whichParam]] = tempAgentData[i]
      ItemUpdate(gGraphicSettingDialog, gGraphicRealPosList[whichParam], gGraphicDialogItemList[gGraphicRealPosList[whichParam]])
      whichParam = whichParam + gAgents
    end repeat
  end if
end

```

on theGraphicCallback (event, eventData, itemPropList)

```

gGraphicDialogItemList[eventData].value = itemPropList.value
if symbolP(event) then -- basic error check

```

```

case event of
#windowOpening:
  put "inside WindowOpening"
  repeat with i = 1 to gAgents
  end repeat
#itemChanged :
  -find which agent had been changed
  foundAt = -1
  repeat with i = 1 to gGraphicRealPosList.count
  if gGraphicRealPosList[i]=eventData then
    foundAt = i
  end if
  end repeat
  if foundAt = -1 then
    -put"DEBUG: sorry not found on gGraphicRealPosList"
  else
    if foundAt mod gAgents = 0 then
      whichAgent = gAgents
    else
      whichAgent = foundAt mod gAgents
    end if
  end if

  if itemPropList.type = #IntegerSliderH then
    gGraphicDialogItemList[gGraphicRealPosList[whichAgent]].value = "| --- "& string(itemPropList.value) & " ---|"
    ItemUpdate(gGraphicSettingDialog, gGraphicRealPosList[whichAgent], gGraphicDialogItemList[gGraphicRealPosList[whichAgent]])
    if itemPropList.title = "p12" then
      gAgentTimerList[whichAgent].period=itemPropList.value
    end if

  else if itemPropList.type = #PopupList then
    - load graphic into cast member
    if itemPropList.title = "graphicslist" then
      end if
    end if

#itemClicked :

```

```

foundAt = -1
repeat with i = 1 to gGraphicRealPosList.count
  if gGraphicRealPosList[i]=eventData then
    foundAt = i
  end if
end repeat
if foundAt = -1 then
  --put"DEBUG: sorry not found on gGraphicRealPosList"
else
  if foundAt mod gAgents = 0 then
    whichAgent = gAgents
  else
    whichAgent = foundAt mod gAgents
  end if
  case ( itemPropList.type ) of
    #bitmap : beep
    #defaultPushButton : beep
    #pushButton :
      case itemPropList.title of
        "Save Settings":
          put "Save agent " & foundAt
          saveGraphicSettings whichAgent
        "Load Settings":
          loadGraphicsSettings whichAgent, ""
        otherwise put "Button " & itemPropList.title & " not recognised"
      end case
    #cancelPushButton : beep
  end case
end if
#windowOpening: put "Window Opening"
#windowClosed: put "Window Closed"
#windowZoomed : put "Window Zoomed"
#windowResized :put "Window Resized"
otherwise :
end case
else

```

```
    put "other event occurred"  
end if  
end
```

on saveGraphicSettings agentNum

```
tempAgentData=[]  
whichParam = agentNum  
gList=gGraphicParam-2  
repeat with i = 1 to gGraphicParam  
  case i of  
    1: gGraphicDialogItemList[gGraphicRealPosList[whichParam]].value="Agent "&agentNum  
  end case  
  
  tempAgentData.append(gGraphicDialogItemList[gGraphicRealPosList[whichParam]])  
  whichParam = whichParam + gAgents  
end repeat  
tempAgentData=string(tempAgentData )  
saveText tempAgentData  
end
```

Performance Dialog Box

--this script contains handlers to setup the performance dialog box

global debugMode

global gPerformanceSettingDialog, gPerformanceDialogPropList, gPerformanceDialogItemList

global smileyIndex

global gPerformanceParamList, gPerformanceRealPosList, gRealPos

global gAgents, gPerformanceParam, gSections, gPerformanceList, gAudioList, gDurationList

global gAgentTimerList, gPerformanceParamNum, gPerformanceSettingFileList

on performanceDialogSetup col, row, sections

gPerformanceSettingDialog = new(xtra "mul")

gPerformanceDialogPropList = GetWindowPropList(gPerformanceSettingDialog)

gPerformanceDialogPropList.name = "!----- Performance Configuration Settings -----!"

gPerformanceDialogPropList.callback = "thePerformanceCallBack"

gPerformanceDialogPropList.width = 200

gPerformanceDialogPropList.modal = false

gPerformanceDialogPropList.closeBox = TRUE

gPerformanceDialogItemList = []

-- Set up the beginning of the dialog box

templtemPropList = GetItemPropList(gPerformanceSettingDialog)

templtemPropList.type = #windowBegin

gPerformanceDialogItemList.append(duplicate(templtemPropList))

gRealPos= 1

repeat with i = 1 to row

repeat with j = 1 to sections

case j of

1:-- Set up the beginning of an overall group

templtemPropList = GetItemPropList(gPerformanceSettingDialog)

templtemPropList.type = #groupHBegin

gPerformanceDialogItemList.append(duplicate(templtemPropList))

gRealPos = gRealPos+1

2:-- puts a row of titles from parameter list

templtemPropList = GetItemPropList(gPerformanceSettingDialog)

```

templtemPropList.type = #label
templtemPropList.value = gPerformanceParamList[i]
templtemPropList.title = "paramLabel" & i
gPerformanceDialogItemList.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
-- create columns
repeat with k = 1 to gPerformanceParamNum
  templtemPropList = GetItemPropList(gPerformanceSettingDialog)
  templtemPropList.title = "P" & i & "A" & k
  gPerformanceDialogItemList.append(duplicate(templtemPropList))
  gRealPos=gRealPos+1
  gPerformanceRealPosList.append(gRealPos)
end repeat
3:-- end group
templtemPropList = GetItemPropList(gPerformanceSettingDialog)
templtemPropList.type = #groupHEnd
gPerformanceDialogItemList.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
end case
end repeat
end repeat
-- Last, set up end of window
templtemPropList = GetItemPropList(gPerformanceSettingDialog)
templtemPropList.type = #windowEnd
gPerformanceDialogItemList.append(duplicate(templtemPropList))
gRealPos = gRealPos+1
--load with default settings
repeat with i = 1 to gPerformanceParamNum
  loadPerformanceSettings i, gPerformanceSettingFileList&i&".txt"
end repeat
end
end

```

on thePerformanceCallback (event, eventData, itemPropList)

```

gPerformanceDialogItemList[eventData].value = itemPropList.value
if symbolP(event) then -- basic error check

```

```

case event of
#windowOpening:
  put "inside WindowOpening"
  repeat with i = 1 to gAgents
    -gPerformanceDialogItemList[gPerformanceRealPosList[whichAgent]].value
  end repeat
#itemChanged :
  --find which agent had been changed
  foundAt = -1
  repeat with i = 1 to gPerformanceRealPosList.count
    if gPerformanceRealPosList[i]=eventData then
      foundAt = i
    end if
  end repeat
  if foundAt = -1 then
    --put"DEBUG: sorry not found on gPerformanceRealPosList"
  else
    if foundAt mod gAgents = 0 then
      whichAgent = gAgents
    else
      whichAgent = foundAt mod gAgents
    end if
  end if

  if itemPropList.type = #IntegerSliderH then
    gPerformanceDialogItemList[gPerformanceRealPosList[whichAgent]].value = "& string(itemPropList.value) & "
    ItemUpdate(gPerformanceSettingDialog, gPerformanceRealPosList[whichAgent], gPerformanceDialogItemList[gPerformanceRealPosList[whichAgent]])
    if itemPropList.title = "p12" then
      gAgentTimerList[whichAgent].period=itemPropList.value
    end if

  else if itemPropList.type = #PopupList then
    -- load performance into cast member
    if itemPropList.title = "performancelist" then
      performanceFile = the moviepath & "performance\" & itemPropList.value
      importFileInto(member(whichAgent,"performance"),performanceFile)
    end if
  end if
end case

```



```

    end if
  end if
#itemClicked :
foundAt = -1
repeat with i = 1 to gPerformanceRealPosList.count
  if gPerformanceRealPosList[i]=eventData then
    foundAt = i
  end if
end repeat
if foundAt = -1 then
  --put"DEBUG: sorry not found on gPerformanceRealPosList"
else
  if foundAt mod gAgents = 0 then
    whichAgent = gAgents
  else
    whichAgent = foundAt mod gAgents
  end if
  --put"DEBUG: Found at: " & foundAt & "real pos is: " & gPerformanceRealPosList[foundAt]
  case ( itemPropList.type ) of
    #bitmap : beep
    #defaultPushButton : beep
    #pushButton :
      case itemPropList.title of
        "Save Settings":
          put "Save agent " & foundAt
          savePerformanceSettings whichAgent
        "Load Settings":
          loadPerformanceSettings whichAgent, ""
        otherwise put "Button " & itemPropList.title & " not recognised"
      end case
    #cancelPushButton : beep
  end case
end if
#windowOpening: put "Window Opening"
#windowClosed: put "Window Closed"
#windowZoomed : put "Window Zoomed"

```

```

    #windowResized :put "Window Resized"
    otherwise :
    end case
else
    put "other event occurred"
end if
end

```

on loadPerformanceSettings agentNum, defaultfile

```

gPerformanceList = getfiles("performances")
tempAgentData=[]
tempAgentData = openAndReadText(defaultfile)
-- this formatting is needed to turn string into a value (list).. don't ask me why, took me a day to find out
tempAgentData = SearchAndReplace(tempAgentData, "<Void>", "void")
tempAgentData = value(tempAgentData)
whichParam = agentNum
paramCounter = tempAgentData.count
tempAgentData[1].value = "-A G E N T "&agentNum&"-"
--need to effect birth rate of child object
gDurationList.append(tempAgentData[12].value)
repeat with i = 1 to paramCounter
    -- repeat with i = 1 to gPerformanceParam
    gPerformanceDialogItemList[gPerformanceRealPosList[whichParam]]=tempAgentData[i]
    ItemUpdate(gPerformanceSettingDialog, gPerformanceRealPosList[whichParam], gPerformanceDialogItemList[gPerformanceRealPosList[whichParam]])
    whichParam = whichParam + gAgents
end repeat
end

```

on savePerformanceSettings agentNum

```

tempAgentData=[]
whichParam = agentNum
repeat with i = 1 to gPerformanceParam
    case i of
        1: gPerformanceDialogItemList[gPerformanceRealPosList[whichParam]].value="Agent "&agentNum

```

```
end case

tempAgentData.append(gPerformanceDialogItemList[gPerformanceRealPosList[whichParam]])
whichParam = whichParam + gAgents
end repeat
tempAgentData=string(tempAgentData )
saveText tempAgentData
end
```

Go Frame

-- this handler causes the playback head to loop around a *single frame*

on exitFrame me

```
  go the frame  
end
```

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Publications

Software intervention in the process of improvisation

Tim Sayer

Dartington College of Arts, UK
College of St. Mark and St. John, Plymouth, UK
timsayer@fc.marjon.ac.uk

Abstract

This paper provides a rationale for the possible development of software interfaces, the purpose of which is to provide opportunities for an improvising musician to construct a performance which, on the one hand allows them to engage with sonic and visual material produced by generative algorithms and on the other challenges the conscious and sub-conscious cognitive processes which govern their normal performance practice. Both cognitive psychology and communication theory offer great insight into the evolution of human cognisance and provide pointers to models with which the activity of musical improvisation could be interpreted. In the course of this paper I have tried to relate academic concepts and theories to material gleaned from improvising musicians, giving credence to their opinions and drawing inference from their experiences.

Keywords: cognition, communication, consciousness, improvisation, performance, psychology

1 Introduction

There is not a system in the material world that exists in isolation from all other systems, be it physical, biological or conceptual. Musical improvisation is no exception. Not only is this activity non-autonomous but it continues to defy a consensual definition amongst those who engage in it and those who study it. Like so many culturally defined super-ordinate terms 'improvisation' is used in reference to a range of human activities and even when applied to those that are classified as 'musical' it fails to provide a consistent term of reference.

Superficially musical improvisation, as with the spoken word, appears to be formulated and delivered almost in a single process, the conceptualisation of an idea being translated into spoken language virtually immediately in many instances. As Holtzman suggests it is only by scrutinising the processes of music and language at their component level that we can avoid the pitfalls of unsubstantiated generalisation in the relationship between the two activities.

Like natural language, music is a system that consists of a hierarchy of systems. Each system has its fundamental components: the 1/50,000th-of-a-second micro-sound sample, the note or sound event, themes and phrases, and ultimately the structure of a complete work. Each system has its rules for describing its structures: for combining and sequencing elements. And each system can itself be seen as the base element of another system at a different level in the hierarchy.

Holtzman (1994: 156)

Viewing musical improvisation, which I will refer to only as 'improvisation', as a

communication system comprising many subsystems will I hope clarify the areas of the process under examination in this study. The domain I have particular interest in comprises systems that support the preconception, conception and formalisation of ideas. Although there seems not to be a large body of work providing an examination of this domain, specifically in relation to the spontaneous creation of musical material, there does exist a wealth of material within the fields of evolutionary studies, cognitive science and linguistics with which to construct plausible explanations of improvisational behaviour.

This endeavour does in fact have a purpose, and that purpose is to provide a theoretical foundation on which to construct computer based performance systems for use in conjunction with improvising musicians. The technical detail of which will be provided in a later paper.

2 Improvisation and human behaviour

Many aspects of human behaviour are governed by what we know and what we understand. If we know that a particular type of behaviour is likely to cause us pain then we will obviously avoid it. If we understand and learn how pain works we then have the opportunity to avoid as many pain causing situations as our understanding permits. This human behavioural characteristic is not of course static and when viewed with an evolutionary perspective provides insight into the influence of brain development on human behaviour. As Gurney suggests the development of the thalamus and neocortex has led to greater control over behaviour thus reducing automatic or reflex type responses in favour of learned responses.

Similar reasoning points to the separation of the new planning and reasoning areas of the brain from the older 'emotional' centres. It is conjecture that herein lies the reason for man's 'objectivity'. He is less subject to the immediate demands of his emotions. The

separation of the reasoning and emotional centres would have provided the opportunity for man to cope rationally with most situations, since it is known that strong emotions tend to disrupt organized behaviour, including learning.
(Gurney 1973:42)

The consequences of a cognitive pull such as this could have significant ramifications within the field of improvisation. Many of the frustrations expressed by improvising musicians centre around the continuous battle to generate original material, to evolve the music beyond that which has been played before. In his conversation with Derek Bailey, Steve Lacy seems to be identifying the behavioural tendency identified by Gurney, to organise and learn, as he expresses his disillusionment with the field of jazz.

Why should I want to learn all those trite patterns? You know, when Bud Powell made them, fifteen years earlier, they weren't patterns. But when somebody analysed them and put them into a system it became a school and many players joined it. But by the time I came to it, I saw through it - the thrill was gone. Jazz got so that it wasn't improvised any more.
(Bailey 1992:54)

It is perhaps significant that Lacy never proposes a benchmark with which to measure successful improvisation. He describes that which he finds worthy of the title 'improvisation' with adjectives such as 'free' and 'progressive' without opening up those descriptions to scrutiny. Perhaps Lacy is implying that true improvisation is characterised by a streaming of material from the performers psyche without influence or contamination, an activity not unlike the Surrealists process of automatic writing pioneered by Breton, the premise of which is now generally accepted to be neurologically impossible. It is ironic that in this critical context the likes of Lacy fall foul of their own critique. Modern psychology has deconstructed the mind to the point that there is no haven for his notion of creativity to exist. As Kenneth Gergen suggests with each and

every aspect of our interior space allocated to new ages conditioning or populist psychological diagnosis there is no room for a generalised theory of being.

In effect, through the various technologies of social saturation, there is an explosion in the vocabulary of the interior. And this explosion brings to a virtual close an age of relative homogeneity. We slowly lose our sense of assuredness in 'what there is' - for example, whether there is in fact any mental disease, any real creativity, free will, moral sentiment, superior aesthetic taste, and so on.

(Grodin and Lindlof 1996 133)

Behavioural psychology seems to reveal other traits in improvising musicians, traits, which it seems we are hard wired to exhibit and which appear in everyday life. There are numerous experiments that have revealed a tendency in animal behaviour to avoid negative experiences and be attracted to positive experiences. In humans, conflicts are often caused by artificial interjections into this scenario such as caffeine or nicotine, with the short-term effect satisfying the positive pull but in the long-term producing a more negative effect. Similarly in the production and consumption of music, human behaviour is perhaps governed by what we *know* rather than by what we *understand*. It is a cliché to describe consumers of art products in these terms but rarely is this notion applied to producers. Within the context of musical improvisation and particularly within the genre of jazz many great performances have taken place by performers who know what it takes to move an audience. Many academics and observers have deconstructed and analysed performances in order to understand what was produced by the performer and have succeeded in representing the material in accordance with a particular analytical method, but this does not address why a performance has the effect it does. A performer can often deduce *what* has an effect but not *why*, a behavioural influence which Derek Bailey identifies as being detrimental to a

performance.

Alain Danielou, writing about the difficulties for Asian musicians working within the Occidental entertainment system describes exactly the problem which has also affected Western performance music such as flamenco, jazz and, increasingly, 'free' music. 'When the musicians note a positive reaction from the public, they are tempted to reproduce the effect, which provoked this reaction and consequently one can understand how a rapid deterioration of the music performed could occur. The musician becomes little more than an actor who repeats his tricks when he notices that the public reacts favourably.

(Bailey 1992 44)

We see then that this type of 'gratification seeking' performance conditioning goes a long way to reinforce the behavioural changes that have been initiated by physiological changes in the brain. Gurney once again suggests that this characteristic has steadily developed as a feature of human evolution.

As Lorenz pointed out, one of the themes of man's emergence was the loosening of instinctive reflex actions in favour of the learned control of voluntary behaviour.

(Gurney 1973 40)

Gavin Bryars, once working as a bass player in the field of improvisation, chooses now to create music through composition. The demise of his belief in improvisation as a valid art form came as a result of experiencing performances, which in some sense seemed to be fraudulent. He identified the same behavioural traits as Alain Danielou but in addition raises the question of the performers' objectivity.

One of the main reasons I am against improvisation now is that in any improvising position the person creating the music is identified with the music. The two things are seen to be synonymous.

(Bailey 1992 115)

Bryars seems to be intimating that it is impossible for an improvising musician to remain objective during a performance and that this psychological state compromises the

autonomy of the artwork. It is not only within the field of improvisation that this psychological state has been identified. The Russian philosopher Peter Ouspensky in his paper *The psychology of man's possible evolution* identified four general states of consciousness; sleep, waking sleep or relative consciousness, self-consciousness and objective consciousness. These states exist on a continuum from subjective to objective with state number one, sleep, being purely subjective. Ouspensky suggests that people tend to spend the vast majority of their waking life in state number 2 in which their subjectivity is extended to include the perception of 'I' and 'not I'. Within this state he defines a number of characteristics and traits that people exhibit, one of which lends weight to Bryars' observations.

'Identifying' or 'identification' is a curious state in which man passes more than half of his life. He 'identifies' with everything: with what he says, what he feels, what he believes, what he does not believe, what he wishes, what he does not wish, what attracts him and what repels him. Everything absorbs him, and he cannot separate himself from the idea, the feeling, of the object that absorbed him. This means that in the state of identification man is incapable of looking impartially on the object of his identification. It is difficult to find the smallest thing with which man is unable to 'identify'. At the same time, in a state of identification, man has even less control over his mechanical reactions than at any other time. (Ouspensky 1940 42)

If the omnipotence of this state, as Ouspensky seems to be suggesting, exists, then the premise that underpins many areas of communication theory must perhaps be re-evaluated. That premise being that when two or more sentient beings communicate they are performing a conscious objective act. This argument has been employed by Karl Rosengren and others to distinguish the way human beings communicate from other animals.

When human beings communicate, we know that we do so. Each one of two communicating participants is aware of the (sometimes potential) presence of the other, and of the fact that communication is occurring (or may occur).

(Rosengren 2000 36)

Another flaw in this premise that supports Ouspensky's theory is of course that much of our communication exists on channels that are not generally subject to intellectual filtering, body language and vocal intonation being two obvious examples. This situation exists in an improvised music setting as much as anywhere else. Facial expression, speed of movement, body gesture, physical positioning, etc. are all able to communicate information in which the performers' perceived intent often plays no part. Rosengren's typography extends his model of communication to include what he terms, unintentional and subconscious transmission.

While the inclusion of these aspects offer us insight, by way of exemplars of the types

		Individual is conscious of action/behaviour	
		Yes	No
Action/behaviour is intentional	Yes	1 communication as action	2 communication as subconscious action
	No	3 bodily behaviour such as blushing, stuttering, sweating, trembling	4 unconscious bodily behaviour such as small facial changes

Table 1. A communicative-orientated typology of action and behaviour. (Rosengren 1984 37)

of behaviour that are generally regarded as involuntary, the overall model remains problematic. Ouspensky's notion of consciousness as a continuum on which a human activity can be placed in accordance with a person's overall psychological or evolutionary state seems more plausible.

In connection with this I must say at once that I do not mean what is called in modern psychology 'the subconscious' or 'the subconscious mind'. These are simply wrong expressions, wrong terms, which mean nothing and do not refer to any real facts. There is nothing permanently subconscious in us because there is nothing permanently conscious; and there is no 'subconscious mind' for the very simple reason that there is no 'conscious mind'.

(Ouspensky 1940 29)

3 Improvisation and spoken language

So we are faced with an 'improviser' whose evolution is closing down the intuitive and automatic centres in his brain, who has a prejudice for the learned rather than the invented, who succumbs to a weakness for self gratification, who is incapable of being objective about their own music and who lives under the illusion that they have conscious control over their communication. In attempting to resolve this internal crisis that afflicts the improvising musician it may be helpful to undertake a digression into the world of linguistics.

The term improvisation as defined within the context of this paper refers to the field of musical performance but as a super ordinate term it can be applied to a whole range of human endeavours. In some ways improvisation is more prevalent in the field of spoken language than in music. It is more common for a musical transmission to be pre-prepared rather than spontaneous, where as spoken language is more likely to be spontaneous rather than pre-prepared, at least in detail. Although the medium of spoken language affords the facility to ponder and hone a

thought before it is transmitted, the dynamics of discourse often make it stylistically inappropriate. Spoken discourse is of course regulated by the context in which the discourse is taking place. When the discourse content is of a serious or emotionally charged nature the level of consideration given before delivery is likely to be higher than if the discourse is of little or no consequence. The process of musical improvisation has many parallels with delivering spoken discourse but also fundamental differences. If we assume that spoken discourse has an important and fundamental human function outside the transmitting and receiving of information then the link with improvisation becomes more vivid. When such discourse is taking place its objective, to connect one or more human beings through the spontaneous generation of sound, becomes very similar in method to a musical improvisation. Indeed Kenneth Gregen's notion of the 'relational sublime' offers justification for why such a connection between spoken language and musical improvisation should exist. Gregen points to deeper structures that exist below the encoded transmissions of spoken natural language, structures open to more primal interpretation.

Yes, although this realm of the sublime cannot be captured in language, we can appreciate its dimension. How are sounds and markings converted to what we take to be language? For how does language acquire its intelligibility? Here we must envision primordial processes of relationship - the pulsing coordination of movement and sound - that slowly turn the amorphous into the meaningful.

(Grodin and Lindlof 1996 138).

A parallel can perhaps be drawn between that which is 'primordial' in Gregen's 'relational sublime' and the 'deep structures' of Chomsky's 'transformational grammar'. The innate capability of the mind to formulate grammars which Chomsky saw as a substrata of human communication seems to relate to Gregen's belief in the relationship as the bonding layer below natural language, in as much as they exist

universally and are innate. The suggestion is therefore that we come into this world pre-loaded with the facility to interface onto any cultural language that we happen to be born into, as Fodor acknowledges, when we are born our minds are not a clean sheet.

My view is that you can't learn a language unless you already know one. It isn't that you can't learn a language unless you've already learned one.
(Fodor 1978 65)

Fodor's metaphor of the internal state of the human mind resembling that of a computer allows us to draw the analogy between machine code and the human internal language, both of which require a compilation process in order to interpret external communication. In the case of the human, the external language is of course learnt and is translated at run time rather like an interpreted language.

When you find a device using a language it was not built to use (e.g. a language that has been learned), assume that the way it does it is by translating the formulae of that language into formulae which corresponds directly to its computationally relevant physical states. This would apply, in particular, to the formulae of the natural languages that speakers/hearers learn, and the correlative assumption would be that the truth rules for predicates in the natural language function as part of the translation procedure.
(Fodor 1978 67)

What is suggested then is that human communication comprises two levels of interpretation, one external and one internal. The external level dealing with a culturally defined natural language and the internal dealing with biologically defined 'language of thought', as Fodor describes it. Fodor argues that the

notion of human beings thinking in natural language is impossible. That would be to suggest that children in a pre-linguistic state could not think and that non-linguistic animals were incapable of thought.

One way of describing my views is that organisms (or, in any event, organisms that behave) have not only such natural languages as they may happen to have, but also a private language in which they carry out the computations that underlie their behaviour.
(Fodor 1978 68)

This two-phase communication model seems to support Chomsky's concept of deep and surface language structure and combined with Greco's notion of the 'relational sublime' can perhaps offer an insight into improvisation. In these terms it is clear that within the overall process of communication the encoding and transmission of natural language is only part of the story but for an improvising musician to make this distinction is a non-trivial task. John Zorn's description of a personal language developed by an improvising musician with his instrument could be vaguely equated to Fodor's private language. Zorn goes on

*Greco's
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however, to describe this language as evolving through relationships with other musicians thus blurring the distinction between the notions of public and private language. Bailey, on the other hand, acknowledges that drawing an analogy between improvisation and language is only useful in terms of describing 'a vocabulary' shared by musicians. He seems to be alluding to a similar strata of communication as Chomsky's surface structure.

The analogy with language, often used by improvising musicians in discussing their work, has a certain usefulness in illustrating the development of a common stock of material - a vocabulary - which

takes place when a group of musicians improvise together regularly.
(Bailey 1992 106)

If Chomsky's 'transformational grammar' concept could be applied to improvisation, the process is likely to be fraught with difficulties. It is perhaps easier to conceptualise a situation in spoken language where the truth rules for predicates in the surface structures have a correlation with internal states in the deep structure. It is impossible to conceptualise and express such a situation in improvised music without retorting to a symbolic representation using natural language. In the study of the 'internal language' Fodor suggests that perhaps it is not necessary to try to determine exactly what the correlation is between inner and outer language but that it is sufficient for that correlation to be consistently undertaken. This relieves the improvising musician of the onus to define what might be called the 'deep structures' of his performance in any other terms than those in which they are originally manifest.

Notice that the use of a language for computation does not require that one should be able to determine that its terms are consistently employed; it requires only that they should in fact be consistently employed.
(Fodor 1978 70)

Perhaps the reasons this correlation is easier to conceptualise when considering spoken language again relates back to our evolutionary heritage.

Other forms of non-verbal communication include dance and music. . . All of these arts seem to be about as old as man. Actually, their elementary forms must be even older, since the imitative, representing function of gesture and mimics must have been used for tens of millennia before human symbolic language with highly specific articulation developed. Indeed, the most ancient musical instrument (a flute) to be discovered to date is estimated to be between 40,000 and 70,000 years old, which is older than the estimated age of human speech.
(Rosengren 2000 40)

The human evolutionary dynamic, moving from the reflex response to the learned, seems to favour the development of natural language rather than that of improvisation although it seems safe to assume that man was musical before he was linguistic. And although the internal operation of the brain, i.e. the way the mind worked, was significantly different then from modern man, the need to retain the ability to create spontaneous expressions of emotion seems to have been retained.

The evolutionary change did not exclude emotion but tempered it. Man did not abandon the pleasures of satisfying his needs. Instead he learned to postpone them in the interest of long-term objectives.
(Gurney 1973 42)

Perhaps the improvising musicians can be indulged in their internal dilemma between the learned and the invented, they are it seems caught between the need to satisfy a pre-linguistic urge for sonic self-expression and the brains modern day urge to suppress reflex response.

4 Improvisation and computer software intervention

There are many instances of composers and improvisers employing processes to circumvent the human ego. The most famous of which is possible John Cages chance operations. As Paul Rudy identifies in his reconstruction of Cage's *Child of Tree*, there was a need for Cage to resolve issues previously raised in this paper.

Cage's prior objection to improvisation was its basis in the confines of a performers memory and taste which directly contradicted his dada influences. Improvisation with plant material (cactus and seed pods in 'Child of Tree', and conch shell in 'Inlets') solved this dilemma through removing the familiarity of previously learned (and practiced) patterns, by introducing a completely unpredictable instrument into the performance.
(Rudy 2001)

There are, then, precedents for an interventionist approach to constructing performances based on improvisation. In the

case of the cactus in Cage's performance the nature of the interaction was obviously unidirectional or simplex as it is known in communication terminology. The sounds generated by the cactus could influence the behaviour of the performer but the performers' sound could not influence the behaviour of the cactus. Computer software based intervention allows this mode of interaction to be expanded. Half-duplex communication describes a situation where bi-directional communication exists but not simultaneously. It is this mode that human beings employ to engage with spoken language, it is very difficult for humans to both receive and decode a communication while also transmitting one. When computers communicate with each other they often use full-duplex protocols that facilitate simultaneous bi-directional transmission. The abstract artist Harold Cohen, developer of the AARON drawing system based on artificial intelligence, maintains that in computer software artists have for the first time a tool which can monitor an external stimulus and change its self simultaneously.

There's a fundamental difference between what we traditionally call a tool, which requires feedback to be conducted to and from the human user for operations to take place, and a device that contains its own feedback paths, that can conduct its own investigations and modify its own behaviour on the basis of what it's able to feed back to itself from the results of what it has done.

(Holtzman 1994 218)

Although humans do not possess a full duplex mode when using natural language there is brain support for the undertaking of simultaneous processes. The cerebellum regulates and adjusts both voluntary and reflex actions. It automatically handles much of the processing and therefore behaviour between the initiation of an event and its goal state. It acts, as Gurney describes, as a kind of 'neural automatic pilot'. When we walk across a room the cerebellum will handle our balance and foot

placement leaving the cortex free for other processing. This facility is likely to have been one of the growth areas in human development, as the cerebellum has increased in size relative to the brain stem. We could here extend Fodor's computer metaphor with an analogy to multi-tasking operating systems. These achieve the simultaneous execution of multiple processes by ordering their execution according to their priority in interrupting and gaining the attention of the processor or in the brain's case voluntary control.

The 'highest' brain stem centres of reflex control to develop were the basal ganglia. Not only do these nuclei form a motor equivalent to the thalamus and its development on the sensory side, but they lie at the base of cerebral hemispheres next to the thalamus. These ganglia probably do not control movement, as they seem to be involved on general muscle tone and rhythmic behaviour. Through these centres we can carry on one activity while engaging in another, more sophisticated one: the ability to 'whistle while you work' for instance.

(Gurney 1973 40)

Computer software based intervention in the process of improvisation with its full duplex capabilities allows for the creation of an architecture where a human performers' reflex and voluntary behaviour can perhaps be influenced. Decomposing the improvisational activity into discrete processes where one process is given precedence over another could allow reflex behaviour to be stimulated in the subordinate process. Constructing a software performance system where a conscious voluntary activity exists simultaneously with the sonic activity has a similarity to the devices used in the work of John Zorn.

My early game pieces were sports, like Lacrosse, Hockey, Pool, Fencing and I got bored with those and started using war games, kind of bookshelf games. The rules were intense, so thick, you know, and if you write the rules out for the game Cobra they are impossible to decipher.

(Bailey 1992 76)

So what possibilities are created when the 'rule base' for an improvisation is divorced from the act of creating sound, as in the scenario described by John Zorn. And what happens when the performer is fed back information on his status on which he is required to act. The performer's voluntary faculties deal with the rules of engagement and the construction of strategies while his reflex action interprets and implements those strategies. Could this induce the type of rare experience Bailey identifies, that perhaps drive musicians to choose improvisation as a mode of expression.

A lot of improvisers find improvisation worthwhile. I think, because of the possibilities. Things that can happen but perhaps rarely do. One of those things is that you are 'taken out of yourself'. Something happens which so disorients you that for a time, which might only last for a second or two, your reactions and responses are not what they normally would be. You can do something you didn't realise you were capable of. Or you don't appear to be fully responsible for what you are doing.
(Bailey 1992 115)

Evan Parker makes reference to this state seeming to identify contextual influences as a powerful force in changing a musician's behaviour.

It can make a useful change to be dropped into a slightly shocking situation that you've never been in before. It can produce a different kind of response, a different kind of reaction.
(Bailey 1992 128)

The case then, for software intervention in the process of improvisation, is not about citing the overall responsibility for the performance with either the performer or the computer; it is embodying it in the interactivity, in the sublime relationship between the two. I am not advocating an artificial intelligence system learning from a performer and producing rule based music, but rather an attempt to extend an improvisers potential by defining rules of engagement. The objective in

artificial intelligence to learn, store and predict is not of this paradigm. As the computer scientist Frederick Brooks suggests, the future for computing is in extending and not mimicking human potential.

I believe the use of computer systems for intelligence amplification is much more powerful today, and will be at any given point in the future, than the use of computers for artificial intelligence (AI). In the AI community, the objective is to data base. In the AI community, the objective is to build systems that amplify the human mind by providing it with computer-based auxiliaries that do the things the mind has trouble doing.
(Holtzman 1994 218)

The type of software intervention I am suggesting fits well with this AI objective. Performance interfaces that listen, feedback and extend the performer rather than produce a passive reaction provide opportunities to exploit synchronous channels of communication. The interface functioning as 'agent provocateur' can provide not only sonic stimulation for the performer but also visual stimulation in the form of an objective or challenge, with the performer being subjected to the consequences of their performance as it unfolds. Defining the parameter space for the interface and its components is the major challenge for the software developer. The parameter space needs to facilitate rules of engagement that support the performers artistic practice while also providing emancipation from preconceived and mechanical processes. The rules of engagement should provide a consistent and accessible framework for the performer but without rendering the interface predictable.

Human evolution may be changing our inner world in ways that allow us to learn more easily, undertake more simultaneous processes and become less reliant on our reflex actions, but we still have an innate desire for emotional expression. Symbolic language has perhaps to a certain extent obscured our means of direct expression but in our networked world we are

redefining the means of achieving this. By using software interfaces to intervene in the process of improvisation we have an opportunity to bear influence on the performance parameters hitherto embodied in the relationships between and within components of improvised performance. Perhaps Gregen's insight may show the way forward for the design of interactive performance systems.

As we succeed in losing the self, the security of single rationalities and give way to the fluid and many-streamed forms of relationships by which we are constituted, we may approach a condition of the relational sublime.

(Grodin and Lindlof 1996 139)

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- Tim Sayer is currently a senior lecturer in digital media and communication at the College of St Mark and St John, Plymouth, UK. Tim is also a freelance trumpeter player and multimedia software developer. As part of his PhD research at Dartington College of Arts, Totnes, Tim is undertaking a study into the relationship between improvisation and cognition as a stimulus to develop new computer-based performance interfaces. The boundary between composed and improvised performance is examined in the design of the new interfaces and various levels of intelligence are incorporated to allow performers to explore issues of 'chance' and 'intent' in spontaneous creative expression. Tim has presented his work at *Cybersonica 2002* at the ICA and *Beyond Noise 2002*, UCSB, California and recently developed interfaces for the *Strange Noise* gathering and the *Night Walking conference* at the South Bank, London.