Live Electronics in Live Performance:

A Performance Practice Emerging from the *piano+* used in Free Improvisation.

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PhD Thesis in Performance Practice

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Declaration:

Hereby I declare that all presented material in this thesis “Live Electronics in Live Performance” is my independent contribution. None of the material has previously been submitted for a degree or other qualification at this University or any other institution.

________________________ London, _______________

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Abstract:

This thesis explores a performance practice within free improvisation. This is not a theory based improvisation – performances do not require specific preparation and the music refrains from repetition of musical structures. It engages in investigative and experimental approaches emerging from holistic considerations of acoustics, interaction and instrument, and also philosophy, psychology, sociopolitics and technology. The performance practice explores modes and approaches to working with the given potentiality of an electronically augmented acoustic instrument and involves the development of a suitably flexible computerised performance system, the *piano+*, combining extended techniques and real-time electroacoustic processes, which has the acoustic piano at its core. Contingencies of acoustic events and performance gestures – captured by audio analysis and sensors and combined to control the parameter space of computer processes – manipulate the fundamental properties of sound, timbre and time. Spherical abstractions, developed under consideration of Agamben's potentiality and Sloterdijk's philosophical theory of spheres, allow a shared metaphor for technical, instrumental, personal, and interpersonal concerns. This facilitates a theoretical approach for heuristic and investigative improvisation where performance is considered 'Ereignis' (an event) for sociopolitically aware activities that draw on the situational potentiality and present themselves in fragile and context dependent forms. Ever new relationships can be found and developed, but can equally be lost. Sloterdijk supplied the concept of knowledge resulting from equipping our 'inner space', an image suiting non-linearity of thought that transpires from Kuhl's psychological PSI-theory to explain human motivation and behaviour.

The role of technology – diversion and subversion of sound and activity – creates a space between performer and instrument that retains a fundamental pianism but defies expectation and anticipation. Responsibility for one's actions is required to deal with the unexpected without resorting to preliminary strategies restricting potential discourses, particularly within ensemble situations. This type of performance embraces the 'Ereignis'.

Live Electronics in Live Performance:

A Performance Practice Emerging from the *piano+* used in Free Improvisation.

Introduction

The two uses of 'live' in the title of this thesis – "live electronics in live performance" – stress that each might not necessarily happen in real-time and that aspects of each can be dislocated from the moment of an assumed 'live' event. While 'live electronics' is establishing itself as a term[1] to distinguish real-time processes used in performance from studio production and the presentation of electroacoustic composition on fixed media such as tape, CD and computer playback, 'live performance' could appear a superfluous description. Performances, however, often rely on prepared material, in the form of notation or practised and memorised activity. The intentional inclusion of 'live performance' in the title signifies that the use of electronics is approached in a performance setting concerned with all aspects of the activity *in situ* – the here and now. In this manner the field of relevant topics range from the musical to the extra-musical, from technology to philosophy and from individualistic concerns to sociopolitical implications.

This thesis proposes a novel performance practice employing extended techniques, preparations and a computerised extension of a piano within a freely improvised musical approach. Musical instruments have a fundamental flexibility and adaptability in their use allowing spontaneous changes as well as subtle alterations and variations. My expectation of a performance system is that these fundamental characteristics are matched by enabling instantaneous adjustments and flexibility while maintaining the means to work with subtleties of control in the sound production. The thesis explores whether these characteristics, found in established acoustic instruments, are also able to be implemented in computerised performance systems. My performance system, *piano+*[2], consists of the acoustic piano augmented by layers of extended techniques and electroacoustic processes. The development of technologically augmented instruments requires discussion of parameter mapping. Introducing the terms 'direct' and 'indirect controllers' as well as 'operational' and 'performative gestures' facilitates an exploration of the interrelationship between design and timbral and structural possibilities during live performance.

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[1] The Grove Music and Oxford Music Dictionaries are not listening an entry header 'live electronics', but it is used within several entries.

[2] Developed and patches programmed by the author in Max/MSP (http://cycling74.com).

A variety of concerns about music improvisation, philosophy, psychology and technology inspired and aided the outline of a performance approach. The discourse of this thesis developed through a symbiosis of theoretical, technological and practical research. The first two pillars are the foundations of theoretical considerations inspired by major philosophical and psychological theories[3] and the development of a sophisticated electroacoustic performance system augmenting the acoustic possibilities of the piano. The third pillar has been the continuous application of this hybrid instrument for freely improvised performances, which explored the use of technology within the sociopolitical context of various ensembles. This generates a problem of research discipline and approach: Edgar O. Wilson makes reference to different scientific disciplines as having their "own practitioners, language, modes of analysis, and standards of validation" to express that an interdisciplinary field is "an increasingly unstable and disorienting region."[4] It does not feel fully appropriate to claim that my practice based research equates to Wilson's problematisation of the scientific limbo between environmental policy, ethics, social science and biology, nevertheless, some of the problems have been encountered. Philosophy as an inspiration for performance practice does not result in a philosophical realisation of music. Likewise, the research into computer based technology to enhance interactivity does not mean the performance practice is an exemplar of interactive technology.

Despite a substantial amount of time committed to the technological development of the *piano+,* this thesis goes beyond an introduction of the computer system to discuss practical and musical outcomes. Conceptual and technical aspects are considered in tandem with practical applications within performances of improvised music. The technical aspect and topic of this thesis might suggest that the research and practice developed out of the electroacoustic, computer or electronic music tradition of the past 60 years, but without negating the technical importance and impact – this research is more concerned with a further development of the piano and its tradition. It is necessary to consider the research and discussions on electroacoustic techniques and processes for the technical aspects concerning the development of the computer program, but it is important to relate to these from an aesthetic perspective to retain a fundamental

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[3] Philosophies by Peter Sloterdijk and Georgio Agamben, theoretical discussion of improvisation by Derek Bailey, Eddie Prévost and Christopher Dell among others, and the psychological PSI theory developed by Julius Kuhl.

[4] Wilson 2009, 9+10.

pianism. The aim was not to reach a practical realisation of a conceptual construct but to engage in a cyclical process with the technical developments influencing the practical work and theoretical research and vice versa.

In general terms, technology used in performance extends the listening experience by introducing new sounds or unheard combinations of sounds through an exploration of the sonic potential and characteristics of the employed devices. Its use might also be motivated to control the perception of the acoustic and visual aspects of performance to enhance the spectacle of the event. Technology might therefore form an integral part of the overall performance or augment specific elements, i.e. in some situations its role might be reducible to being the sound source or the means to manipulate sound.

Sound sculpturing serves as a suitable description for a particular approach to performance relying on technology. Technology is used to activate and set sounds into motion; thus the musician is not involved in the actual sound production, i.e. engaging in the production of the sound waves by physical activity. Sounds and their modifications through effect processes are applied where they seem appropriate. In the same way an artist stands back to review the applied changes to the sculpture while creating the work, the musician gains the opportunity to listen and evaluate the changes without engaging in any physical activity to maintain the music.

Technology appears to have an impact on the music's sociopolitical aspects, particularly – but not exclusively – observable within ensembles. While technology supplies the means to facilitate activity, it also has the means to prevent, overshadow or eliminate contributions. On a wider scale, as Herbert Marcuse states, technology can "promote authoritarianism as well as liberty, scarcity as well as abundance, the extension as well as the abolition of toil"[5].

A fascination with technology might divert attention from the sociopolitical implications of research. In order to allow uncompromising attention to technological possibilities, it may be necessary to explore these in isolation before they can find their way into everyday life. Art and music might be a suitable platform for specific exploration of interaction and novel expression. Recent years have offered countless

[5] Marcuse 1982, p. 139.

technical devices and computerised software that appear to have suitable and exploitable functionalities for musicians.

As computerised tools spread into every aspect of human life, uncertainty arises around the purpose previous tools will retain over time. Will they 'survive' due to functionality and potential use or due to some nostalgic memory, or do they possess qualities unmatched by their electronic competitors? New mobile phone technology pushed the "first" and "second generation cell phones"[6] of the 1980s and 90s aside, and a slowing down of the development of communication tools can probably not be expected in the near future. Although the CD was designed to replace vinyl, records and record players have maintained a use, either by those believing in superior audio quality, or by the DJs and musicians who discovered the record player as a musical instrument in its own right[7]. There may be some truth in the view that electronic devices in everyday life seem to supersede previous tools – making them obsolete, discarded, and possibly forgotten – while tools used in an artistic context might survive. Deliberate artistic focus on 'old' and 'obsolete' technology, including scrap and waste, has explored the unique quality and character of tools, instruments and material. A dependency exists between the instruments and stylistic idioms of the music. As one can observe in the case of the *Ondes Martenot*, for example, once an instrument has been established as appropriate to facilitate the expressive demands of a musical genre, a continuation of its use is more likely[8]. Although history shows that the repertoire written for the previous models of keyboard instruments has been successively substituted by the modern piano, the authenticity movements of the past 30 years have brought the original instruments back into a more widespread focus. In more general terms, musicians around the world, from different cultural backgrounds, use instruments with a long history, with many of them not changing significantly for several years, decades or even centuries.

Electronics and computers have changed how we access, distribute and create music. In little over one hundred years the technology has developed from mechanical, to electromagnetic and analogue, to digital reproduction. The digital age has revolutionised the tools available, in particular through computing, software use and

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[6] http://www.tech-faq.com/history-of-cell-phones.html , last accessed 10/07/2012.

[7] e.g. Christian Marclay (Kahn 2003) Matthew Wright (http://www.matt-wright.co.uk/ last accessed 10/07/2012).

[8] Invented in 1928 by Maurice Martenot, the production finally stopped in 1988.

user-based software design. Computer software can offer tools to record and synthesise sound, with some allowing customisations which reflect individual approaches.

Tangibility in terms of the perception of physical properties through touch enables or enhances the understanding of an object or instrument. The piano keyboard, for example, is a tangible control surface. Its keys can be felt and convey position and orientation while playing the instrument. The accustomed player of an instrument, however, develops a muscle memory, which complements the tangible quality and further enhances the understanding of the control mechanism. The distances of intervals or an octave jump etc. become determined by the muscle memory of fingers and arms, rather than through visual and tangible methods alone. It is possible to consider the 'almost tangible' quality of instruments such as the Theremin, where clearly understandable and learnable properties can be experienced, despite the absence of a tangible control surface. In the course of this discussion it is elaborated how this concern applies to the use of sensors, in particular in connection with the discussion of indirect controllers.

The *piano+* is the result of an individual investigation of electroacoustic augmentation of the acoustic piano after realising that existing software facilitated inspiring and exciting processes but limited my individual creative approach which focused on instant modifications of material in real-time, rather than the preparation and collection of samples to be applied and arranged in composition or performance situations. I would consider this to be a consequence of my conviction that the inclusion of technology in our life ought to reflect ethical concerns and the impact it has on society. I consider it questionable to assume that human behaviour has to adapt to allow technology to suit our life. Although it is essentially out of our control what impact technological changes might have[9], it should be an essential and prime concern that technology ought to be made suitable for human activity and interaction. It is the expectation that humans adapt to technology which appears to be more prevalent in modern society. This attitude is also reflected in the presentation of music of today where the experience of events is enhanced by complex multimedia augmentation.

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[9] The introduction of Short Message Service (SMS) in mobile phone technology was first neglected and the "carriers were astonished by the popularity of SMS" (http://www.mobilepronto.org/en-us/the-history-of-sms.html last visited 10/07/2012) it gathered over time.

Nevertheless, technology yields potential to develop new forms of music making, in particular what is used to create music: the instruments and their sounds. Technology facilitates what is impossible to achieve with acoustic instruments and allows us to overcome the limitations of location and time. However, acoustic instruments offer contingent qualities that have not been matched by electronic means. Within this exchange of the instrumental qualities, further potentially highly characteristic sonic and musical developments can be found: electroacoustically informed acoustic extended techniques and vice versa.

The term contingency[10] is used in this thesis to describe the possibility to predict the character of possible sonic outcomes while simultaneously highlighting aspects which might deviate from the expected. In general terms contingency indicates that the event is possible but not certain. Within this thesis, contingency represents the area between randomness and predetermined events. Contingent events are likely to be in a certain way, but might not be exactly what was expected.

My research explores a middle ground between the acoustic and electronic, although the intersection is not easily defined, or perhaps, might even be totally elusive. In certain performance practices, the exploration of technology might focus on a presentation of artistic aspects, for example, describing its magical characteristics, conceptualising and elaborating narratives and intentions. This thesis, however, centres around conceptual and practical considerations of the tools designed and employed. It forms in this way a symbiosis of the theoretical concept of a performance practice concerned with free improvisation, the investigative and explorative approach to the instrument and the practice applied in performance. Audio files of the complete recordings of solo performances are submitted on the attached Data-DVD[11], also included is the released solo CD *Dazwischen*[12]. Musically the practice has its roots and inspiration in the free improvisations of AMM, the compositional aesthetic of Feldman, Cage and Tudor's realisations and compositions. The conceptual and musical concerns have directed practical research and instrument design as much as the discovery of new sonic potential has influenced the practice and theoretical approaches. So each part

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[10] The use of contingency was inspired by John Tilbury's writing about performing the piano music by Morton Feldman (Tilbury 2001).

[11] For file names of submitted recordings see Appendix VI – Audio Examples.

[12] Lexer 2009, submitted with this thesis.

contributed and informed the outcome and the diversity of the performances, with a diverse range of improvising musicians. Audio files of selected complete duo and ensemble recordings are submitted on the attached Data-DVD[13] and the released duo CD *Blasen* with Seymour Wright[14].

Collaborations in the years 2004 - 2011 have included Eddie Prévost and John Tilbury, who as friends and mentors have stimulated aspects of the performance practice. Further long-lasting musical relationships have included Seymour Wright, Ross Lambert, Jamie Coleman, Paul Abbott, Ute Kanngiesser and Grundik Kasyansky, whom I met in connection with Prévost's Improvisation Workshop[15], and close musical friends from France Frédéric Blondy and Bertrand Gauguet. Other musical encounters with established performers include John Edwards, Jonathan Impett, Steve Noble, Christoph Schiller, Tetuzi Akiyama, Seijiro Murayama, Toshimaru Nakamura, Takehiro Nishide, Lawrence Casserley, Mattin, Michael Vorfeld, Marcus Schmickler and Keith Rowe.[16]

Improvisation is an activity which happens spontaneously in the moment. It adapts its approaches and methods as the encountered conditions of the moment might change rapidly. However, improvisation is not a series of arbitrary reactions: personal intensions give initial direction and purpose to the activity, as well as endeavour and motivation to create, to change current approaches and to develop one's activity.

As it is fundamental to this thesis, an improvised activity might have a hypothesis which substantiates intention, endeavour and development. However, improvisation remains a continuously heuristic activity, where at any point the following step is influenced by the accumulating experience, and the improvisor remains attentive to the environment, especially the social context, where the activity of others might change the context and conditions unexpectedly.

The term heuristic[17] is used within this thesis to highlight the personal investigative quality of improvised activity seen as the basis for this performance practice. This

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[13] For file names of submitted recordings see Appendix VI – Audio Examples.

[14] Wright and Lexer 2008, submitted with this thesis.

[15] Weekly workshop initiated by Eddie Prévost in November 1999 convening every Friday evening in the Welsh Chapel, in Borough, London. I have been participating between December 1999 and September 2011 on a irregular basis of approximately once per month.

[16] Comprehensive performer list: Appendix II – Performers.

[17] This term has been adopted from Prévost 1995.

activity sets out for new experiences to be gained, consciously avoiding the delivery and rendering of preconceived ideas and structures.

The terms “idiomatic” and “non-idiomatic”[18] improvisation were introduced by Derek Bailey to distinguish between two strains of the practice. When musicians are working with and within the known idioms of a defined stylistic genre, as most commonly found within traditional music forms of folk music and jazz, they engage in idiomatic improvisation. While the idioms have developed through cultural and traditional activity, potentially passed on through oral descriptions or loosely notated guidelines, they also emerge when improvising musicians settle on defined theoretical outlines, guidelines and rules on structure, rhythm and tonality. Non-idiomatic improvisation describes a more personal, individual musical voice and claims that stylistic consistencies and resemblance are disconnected to existing references. It is seen as important that the possibilities are given to go anywhere within the practice without constraints and that emerging references are continuously renegotiated within the activity itself. Within this thesis the term idiomatic refers to Bailey’s definition. His definition of non-idiomatic, although considered useful within limits to indicate an individual approach to the material in improvisation, will be scrutinised in the course of the thesis and replaced by a description of an investigative approach to improvisation which maximises the awareness of the potentiality within the musician’s activity itself.

My musical contributions to the performances are undeniably perceivable as a distinctive individual voice while remaining fundamentally pianistic on account of the close links to the tradition of the piano in terms of practice, technique and instrument. However, these performances also highlight the sociopolitical aspect: expectations are suspended, even about the sonic world of the piano itself, and through the use of extended techniques and electroacoustic augmentations an atmosphere is promoted where anything can happen, as any change might be and is possible.

Two distinct discourses run throughout this thesis to reflect the recursive loops within the research and development that interlink the practical, technical and theoretical components.

[18] Bailey 1993.

Chapter 1 develops a historical background focusing on the demand for new instruments of the early 20th Century which emerged simultaneously with the modernistic subversions of established music genres and the abolishing of tonality. Referencing the early Modernists Busoni, Russolo and Kulbin, it is shown that instrumental design has an intrinsic relationship with the formulation of a music style. By indicating differences in approach and linking these to respective sociopolitical concerns, it is argued that an individualisation of musical activity is traceable throughout musical history. An obvious area is the development of electronic instruments and an overview of this focuses on three principle aspects: input, modulation and amplification and explores the fundamental relation between instrumental potential and the emergence of new musical use. Possible input sources are discussed in relation to acoustic instruments that allow their augmentation with electroacoustic processes and the implications for suitable control strategies. The need to develop flexible music systems that facilitate the instrumental potentiality and performance strategy required for freer forms of music making is discussed in relation to Wessel's metaphors for musical control and Croft's paradigms describing different relationships between performer, instrument and electronic sound.

Chapter 2 focuses on the sonic implications of electronic processes. An overview is given describing potential alterations of acoustic properties using amplification, filtering and reallocation of sound events. These processes, fundamental for the creation and manipulation of timbral qualities and structural arrangement, show that electroacoustic processes rely on the playback of captured sounds and their manipulation within the range of fractions of seconds to unspecified long time intervals. The majority of electroacoustic manipulations require time manipulation irrespective of whether the modifications are perceived as changes in timbre and tone (vertical axis) or duration and time (horizontal axis). Electronic alterations can have an implication for the perceived location of sounds and hierarchical distribution which can influence the perception of sounds. On one hand it can make unheard sounds audible, but there is also the potential that other sounds become masked. The final part of the chapter establishes a terminology for the performer's control of the instrument, distinguishing between operational and performance activities. 'Operational tasks' – activity without immediate acoustic results – are often required to set parameters in preparation of electroacoustic processes. 'Performance activity' has a clear causal relationship between activity and sound production. This differentiation between the operational and performative allows to further discriminate between 'direct' and 'indirect' controls. Direct controls relate to the means given to a performer to influence the control parameters directly e.g. with a fader. An indirect controller gathers data from the performance activity, for example using audio analysis or sensor readings to control a parameter of a process. These categorisations help to indicate that a performance system is an intrinsically linked network in which every decision about the design and control has recursive consequences for the overall potential of the instrument which is fundamental to the achievable performance paradigm.

While the fourth chapter forms the continuation of the development of the *piano+*, Chapter 3 interrupts the technical discourse and develops the conceptual basis for the proposed performance practice which had a fundamental influence on the software implementation. Improvisation is described as an activity with underlying principles not exclusive to music. It is then possible to differentiate between genre-specific idioms and an investigative approach exploring the potential of the activity beyond the musical within a freer form of improvisation. The line of argument evaluates the role of negative emotional sentiment towards the situation and activity to motivate progressive development. It introduces a non-linear approach to thought, memory and experience which are developed to establish a concept of a potentiality space related to performance, performer and instrument. An increase of authorship of the performer is noted within the continuum from classical interpretations, to conventional and free jazz, to free improvisation. The need for personal responsibility for one's actions within the formation of the individual musical voice necessary in 'non-idiomatic' improvisation is highlighted. The trichotomy of objectivity, subjectivity and individual responsibility is evaluated using Hegel's concept of the 'Absolute' and Heidegger's 'Ereignis' (event) combined with Agamben's philosophical discourse on potentiality. It is shown that what is perceived as musical activity is only one actualisation of the potential of human activity which is explored within continuous self-reflexive cycles. Established models of improvisation – by Pressing[19] and Sarath[20] – are evaluated in this context. Prévost's declaration of heuristic dialogues within free improvisation find theoretical support in

[19] Pressing in Sloboda 1988.
[20] Sarath 1996.

Agamben's discourse on potentiality and Kuhl's research on human motivation and behaviour. Kuhl's cohesive theory allows a model of how a performer deals with knowledge and experience which abolishes linear causalities. The underlying conceptual similarities between these theories are combined to enable the formulation of a performance strategy that builds on the conscious awareness of the potentiality of the instrument, situation, behaviour and motivation when engaging in a heuristic dialogue. Performance becomes a reflexive journey through a potentiality space during which one departs from oneself in order to progress in experience.

Before a suitable non-linear metaphor for musical performance is applied to concrete aspects of the proposed performance practice, Chapter 4 describes the augmented performance system in technical terms and establishes the possible spatial metaphor of the characteristics of the instrument. The *piano+* is compared to an 'onion' with the acoustic piano as its core and extended techniques as the first layer and the electronics as the second. The discussion of the first layer highlights the contingent qualities of the physical characteristics of the piano sound and categorises the extended techniques by their gestural semblance and variation which alter aspects of the acoustic instrument by influencing the timbral consistency of sounds. As extended techniques pertain to the vertical axis (timbre), the second layer – the electronic augmentation – allows manipulation of the horizontal axis (time), even though the sonic results of the processes might be perceived aurally to affect the vertical axis. The actual design of the computer program and control structure of direct and indirect controls is described in relation to considerations developed in the previous chapters. Using two detailed case studies the use of sound materials is discussed and potential musical applications are outlined. There is a focus on the requirement of sophisticated parameter mapping strategies enabling adaptability and flexibility of the system. As a possible technical solution, the triple controller system is proposed that enables convergent mappings of direct and indirect control sources to allow smooth changes between intentional and contingent controls. Further effect processes implemented in the *piano+* system are briefly outlined before the conceptual instrumental space is assembled in preparation for the central statement of the performance practice in its entirety.

Chapter 5 forms the conceptual continuation of Chapter 3, extrapolating a spherical theory and applying an abstracted model to all aspects of performance: the performer, instrument, context and environment. Sloterdijk's philosophical description of human nature and behaviour using the metaphor of a "sphere" provides an interlinking methodology, in which we regard individual human experience as equipping one's 'inner space' to highlight the relationship of the 'self' to the 'other' in a non-linear manner. A theory of the actual musical activity is developed through a series of models that explain the underlying cognitive processes during improvisation and how we relate to internal and external influences. Within the linear unfolding of the musical actualisation the non-linearity of thought and ideas is imperceptible over the duration of a performance. A distinction is made between the 'rotation' of the conceptual spaces, resembling the changes in perception and perspective within the cognitive realm, and the 'journey' through the spaces as the actualisation of a performance. As established in Chapter 3 the proposed performance practice is concerned with the wider implications of improvisation and the role of technology within the personal and social spheres. This relationship between the 'self' and the 'other' in terms of Heidegger's 'being' and 'being in the world' is exemplified within the issues arising around the use of technology, which, while empowering, also restricts and homogenises human activity. Sloterdijk's spherical discourse deals with this conflict of infinity and immunity in relation to the human tendency to expand individual spaces to over-span others, defined in its extreme case as globalisation. This gives an insight to sociopolitical concerns and underpins the importance and relevance this conflict has to an evaluative approach to the role of technology. This wider excursion is concluded with an outline of the personal space, informed by interests, education, culture and tradition, to introduce a conceptual application of the spherical model to all relevant extra-musical, musical and instrumental considerations.

A fundamental difference is discerned between the reflexive and heuristic qualities of the technological and acoustic elements in the instrumental sphere. While heuristic processes continuously expand the acoustics, the technological can only be explored within fixed (programmed) boundaries. The performance, a journey through this combined performance space, reacts to influences and concerns of its sub-spheres that remain in continuous flux and rotation. This illustrates, while remaining within the same conceptual theory, that shifts in perspective might occur during the proceedings which might not be immediately reflected in the musical outcome.

The development of these conceptual spaces has proven a valuable tool for all practical aspects involved. While the technical development has been concerned with establishing contingent and flexible parameter control, the actual performance activity has benefitted from the insights into the role and approach of the performer with the instrument and other players. Conceptualising changing perception and perspectives as rotation of spheres helps to engage and explore the musical as well as the social aspects during performance, in particular the distinction between the 'self' and the 'other' which emerges in flux. For example, while the instrument might feel integrated into the personal 'inner space' in one moment, it can also become the 'other' that requires focused attention to develop a suitable continuation of the activity.

Chapter 6 outlines the performance possibilities within the aesthetics emerging from this performance practice. Through a comparative evaluation of existing performance strategies regarded as relevant and audio examples of published and unpublished performance recordings, the problematic sampling technique is revisited and evaluated. Furthermore the sonic qualities of the space in between the acoustic and electronic is described as a subversive, semi-autonomous enhancing layer which gives a significant and unique quality to the improvised performance. The unobtrusiveness of the electronics in relation to the musical identity of the performer is highlighted and it is proposed that the *piano+* performance system can be utilised within ensembles without disturbing the musical dialogue between the musicians, because no virtual identity is generated by the technology. The subversive characteristics of the *piano+* have the potential to form an interlinking layer between the performers involved which reflects one's activity, demanding the performer to scrutinise and take full responsibility for the activity and its contingent unfolding.

The practical application of the *piano+* in free improvisation has been the undisputed aim. Although concept and technical aspects are crucial for this project, considerations about practicality and suitability for musical application have been more valuable than a methodological focus on the technical aspects of interactivity. The system has been in frequent use as the examples of referenced performances and recordings indicate throughout the text. A comprehensive list of performances and recordings is supplied in the Appendix.

This thesis presents what I consider important aspects of a performance practice involving technology. It is not a project which set out to explore the possibilities of technical innovation. The resulting music is based on an approach of discovery, where the overall artistic ideas are formed through personal integrity of the practice within a social context, rather than developed in a studio during self-imposed solitude. Most importantly it is the recognition that the musical outcome consists of temporal events within the constantly evolving nature of improvisation. Analysing the arrangement of sounds or the use of pitch of the resulting music has little purpose for the development of the performance practice itself, as the practice neither intends to reproduce any material nor attempts to refine overall structural design. Instead, listening to recordings informs possible directions for future performances, as one practices to detect potential patterns more easily. To detect and respond to this in a performance situation facilitates more alternative routes as one engages with the human potential which is defined by the ability to be "thinking a thought" and "thinking of a potentiality"[21]. Such reflective processes applied *in situ* during performances, in direct response to context and circumstance, has become the fundamental approach in the presented performance practice.

[21] Agamben 1999, 250.

Chapter 1: General Considerations Concerning Live Electronics

Research into extending the sonic potential of an acoustic instrument is closely linked to development of instruments and the augmentation of existing technologies and practices. This chapter investigates selected examples over the past century and isolates areas of particular interest by focusing on techniques involving electronics. I will consciously avoid compositional techniques exploited by the Modernists, although the abolishment of tonality had, especially at the turn of the century, an arguably stronger role in the development of music in the first half of the 20th century than instrumental designs. Arguably, this is a situation that has changed in recent decades.

Sound synthesis receives only brief considerations as the performance practice described in this research avoids explicit exploitation of these techniques. The first part of the chapter identifies possible differences in motivation to develop new instruments and highlights fundamental decisions concerning the underlying concepts of the *piano+* performance system. These are deducted from an overview of a selection of early electronic instruments, showing that fundamental characteristics of electronic instruments need to be evaluated. The presented background ought not to be understood as a comprehensive listing of electronic instruments, but as an indicative selection. The third part discusses amplification and sound manipulation, and the fourth outlines different categories of interaction possible with electronic instruments. The final part of this chapter describes relevant aspects for performance practices in relation to electroacoustic performances and improvisations which engage with sound producing technologies.

It will emerge that technological design alters the relationship between player/composer and electronic instrument and enables modes of performance that differ significantly to those applied at acoustic instruments. The discussion of these techniques considers changes and implications to social aspects within performance.

1.1. Historical Points – the Role of the Instrument Within Musical Progress

Extending the sonic repertoire to expand musical language and compositional tools has played an integral part throughout music history. The development of performance practices associated with any particular genre is directly linked to the employed instruments. Advances and developments in instrumental techniques do not necessarily stem from a compositional motivation alone, but also from the motivation of performers wishing to refine their general interpretation and playing skills to expand the expressive repertoire of sound production[22]. There are numerous examples of how performers, composers and instrument-makers collaborated and how their work became significant for the improvement and development of existing and the development of new instruments. Even when such research is limited to the history of the piano, the impact Beethoven and Liszt had on the development of the modern grand piano is clear. Beethoven's *Hammerclavier Sonata No. 26* indicates the close relationship between improvements of durability and strength of a piano and the heavier playing style featured in the composition. The design of the English action to which the pianist, composer and piano manufacturer Muzio Clementi had contributed[23] was pivotal. Tilman Skowroneck concludes that Beethoven was in the earlier years also aware of the possibilities of the instrument that his compositions "may be seen as a faithful reproduction of what was possible for Beethoven the pianist on the instrument of the day, rather than as idealistic, visionary, or transcendent transcriptions of musical ideas".[24] Boisselot built Liszt's grand piano in 1846[25] for which List showed strong interest in the development and Carl Bechstein set out to design a piano to withstand the ferocity of Liszt's playing[26].

Like most conventional acoustic instruments used within the Classical repertoire the piano has only seen little changes in design over the past 100 years, which are barely more than refinements to the concert grand, which had been established around 1900 by Steinway. However, advances made by Fazioli are significant as they have managed to

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[22] E.g. French Hornist Anton Hampel collaborating with Johann Werner in Dresden between 1750-1755 (http://www.hornplanet.com/hornpage/museum/history/horn_history2.html last visited 20.12.2011) .

[23] http://.ptg.org/Scripts/4Disapi.dll/4DCGI/cms/review.html?Action=CMS_Document&DocID=112&MenuKey=Menu9 last visited 20.12.2011.

[24] Burnham 2000, 177.

[25] http://www.pianosromantiques.com/lisztboisselot.html last visited 20.12.2011.

[26] http://rkassmanpianos.wordpress.com/2011/05/03/liszt-trivia-game-q-5-cutting-edge-liszt/ last visited 20.12.2011.

make the piano sound even clearer and uniform throughout the registers and dynamics, as well as introducing a fourth pedal facilitating "fast passages and glissandi[27] by moving the hammers closer to the strings. Other changes might be related to economic demands by changing materials to lower production costs[28].

1.1.1. Motivation For the New

At the turn of the previous century, Ferrucio Busoni wrote his *Sketch of a New Aesthetic of Music* (*Entwurf einer neuen Ästhetik der Tonkunst*, 1907) proclaiming the need for an expansion of the chromatic scale and new (possibly electrical) instruments to realise it. A much more extreme break from tradition came from Luigi Russolo, declaring in *The Art of Noise* (1913) that the "evolution of music is paralleled by the multiplication of the machine". The edition of Der Blaue Reiter Almanach by Kandisky and Marc published in 1912 also included an essay *Die freie Musik*, the German translation of Nikolai Kulbin's article on 'free music', first published in 1910[29] proclaiming that "like the nightingale the artist of free music won't be restricted by tones and semi-tones"[30]. He introduces his concept of performance and elaborates

> "that audiences can easily distinguish quarter-tones [while ...] eighth-tones are not distinguished [by everyone]. The stronger is their impact, because the nearly recognised and incomprehensible sensations have a strong effect on the soul of humans. [...] The performance of free music is very easy. As with pieces with quarter-tones, one can perform the improvisation of the free notes with the voice, the playing on the double-bass, cello and some brass instruments, without any alteration and without changing the tuning."[31]

He continues to describe possible alteration to other instruments, including the piano for which he even suggests a double layered piano to compensate for the loss of tone

[27] Gustafson 2007, p. 21.

[28] The reasons for instrument development are therefore varying greatly. In the case of the saxophone, its invention was to close the gap of dynamic qualities between the woodwind and the brass. The saxophone was presented to Hektor Berlioz in 1841, who was the first to include it in his arrangements Le Chant Sacré 1844. More marginal but interesting reasons for instrument developments can be found, as for example to improve recording conventional classical instruments by phonographic techniques. There the changes to the instrument were not motivated by musical decisions but by the emerging technology to preserve performances for prosperity. The limitations of early recording techniques, in particular the lack of volume to compensate for the lack of dynamic range of the recording, led to the development of the Stroh-violins (1899), as more directed sound projection was required. It is in this instance important to consider that these instruments emerged prior to the development of microphones.

[29] http://www.zwhome.org/~lonce/SoundArt/SoundArtHistory.html last accessed 19.08.2011.

[30] Kandinsky 2009/1912 p. 125.

[31] Kandinsky 2009/1912 p. 129.

range[32] and suggests the use of live gramophone recording to "transcribe the improvisation of the free tones"[33].

There is an significant difference between these three proclamations concerning the motivation to propose new instruments, or to expansion and change existing ones. Busoni suggests expanding the timbral possibilities of the instruments to advance their expressive range. Russolo demands new instruments and new musical structures, because music ought to reflect the industrialisation of life and include the increasing range of noises humans learn to distinguish from. "The variety of noises is infinite [and we will be able to] combine them according to our artistic fantasy"[34] Kulbin appears to be somewhere in the middle between the two: he seeks to augment what constitutes the definition of music in relation to pitch relations and, despite suggesting alterations to instruments, does so without implicitly seeking new timbres.[35] These motivations are embedded in the Modernist approach and are dependent on changes of the instruments employed, although each is an individual reaction to their contemporary situation of music and how they envisage a possible progress and development. The question whether 'Zeitgeist' has an impact on instruments is fascinating in itself. This topic will return at various points explicitly and implicitly within more general underlying thoughts throughout the thesis. At this stage, the focus ought to be on the strong dependency between the music genres, mirroring social, cultural, intellectual and technological concerns, and the instruments required to facilitate suitable musical expression and portrayal. Jacque Attali's *Noise, the political economics of music* outlines a music history, focusing on the relationship between music and society throughout human history. His proposition that the music actually heralds social structures highlights a profound connection and interrelation between the music and the social. Even when disagreeing the view that social structures are heralded, but instead that music reflects these structures, the concept of detaching art from the social, 'art for

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[32] Kandinsky 2009/1912 p. 130.
[33] Kandinsky 2009/1912 p. 131.
[34] Russolo 2001 p. 12.
[35] Busoni's pupil Percy Grainger's experiments on his concept of 'free music' ought to be mentioned here as it is often quoted as having had the idea of shifting pitches (using Theremins and later on his own prototypes) to defy the stable chords as early as 1900. However I could only verify a quartet for Theremin's scored in 1935-36.

the sake of art'[36], has to be challenged. Attali's writing offered initial inspiration, thoughts and directions which have influenced further research for this discourse.

1.1.2. Progress for Itself or Through Social Relevance

Hugo Ball's quote from the early 20th century suggests a change in the approach of artists to aspire to active "social and political criticism":

> "It is true that for us art is not an end in itself, we have lost too many of our illusions for that. Art is for us an occasion for social criticism, and for real understanding of the age we live in...Dada was not a school of artists, but an alarm signal against declining values, routine and speculations, a desperate appeal, on behalf of all forms of art, for a creative basis on which to build a new and universal consciousness of art."[37]

Cage's conscious attempt to detach his compositions from any individual, social or political implications and connotation has to be considered a highly political act in the context of the 1950s. Whether as a direct response to the politically motivated formalistic tendencies in Eastern Europe and USSR or not, an outspoken disentanglement of music and politics ousts itself as a sociopolitical statement. Both examples show that the conventional understanding of art and music became scrutinised and undermined. However, the work of John Cage also shows how, over time, a reference to Cage's standpoint by other artists for statements of their own political 'detachment' is rendered meaningless. It turns from a rebellious statement, showing in Cage's case an acute awareness of the social implication, into an excuse for ignorance of – or even laziness to engage with – the consequences one's actions have on the social and political realm. Art works can yield potential meaning within a different time and context that can be 'translated' and interpreted into new contexts: they can continue to play a relevant part in the portrayal of social and cultural situations. Attali's terminology of "ritual", "representation" and "repetition"[38] describe qualities too apparent within any music genre that they ought to used as means for analysis. Although these qualities emerged in chronological order throughout music history, Attali's discourse suggests that they continue to exist within contemporary music. Music can be based on aspects of its emotive role and communal customs[39], which are 'ritualistic' qualities. 'Representational' characteristics suit the concept of music performance as a spectacle

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[36] Walter Benjamin equates the "doctrine of l'art pour l'art [...] with a theology of art." (Benjamin 1999, p. 218).

[37] Kostelanetz 1996, p. 90.

[38] Attali 1985, p. 20.

[39] "it makes me feel ..." – "it makes us feel ..."

to capture one's attention[40], and 'repetition' will indicate whether the musical work will withstand over time[41]. Attali's fourth characteristic – 'composition' – reads more as a futuristic prediction rather than a music-historical analysis. Obviously this form of 'composition' ought not to be mistaken with composition as we commonly refer to the activity of writing music by means of producing scores or other suitable guidelines to be interpreted and rendered by performers. Attali's 'composition' describes general changes in modes of production and economic exchange of music. He preempted the increasing individualisation of musical activity, where music is turning back into an activity not solely – if at all – motivated by market forces, products and commodities, and where music is not the means for a career aimed at commercial gains and success.

Music that reflects contemporary concerns deals with contemporary thought, and approaches, including available tools, instruments and devices. It is this very fundamental concern, which suggests a further logical step, if not even an underlying principle: new emerging technologies and their concepts *have* to find their application within music making. The degree and focus can vary and any claim that all musics would have to comply with one particular methodology is erroneous, although possibly unavoidable within its particular cultural and social context[42]. It is through an element of exaggeration that the statements by Busoni and Russolo carry historical significance, rather than through their actual content and detail. These statements expose a problematic orthodoxy in the approach to instruments of their time. In particular, the Futurists' work and motivations to include noise producing machines into performances raises the question of what one considers to be a musical instrument, and not only what constitutes music. This shift in concern starts to challenge established music in a profound and substantial way.

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[40] Fascination about virtuosic delivery – "wow, how is it possible that this ..." – "I've never seen anything like this".

[41] "it's always been regarded as important" – "it's still retaining it's value" – "if people always saw something in this, it must be relevant".

[42] I.e. Boulez on serialism, Reich on Adorno.

1.2. Electronic Instruments

Electronic instruments emerged within the early part of the 20th Century, the *Theremin*[43] and the *Ondes Martenot*[44] are prominent examples. Although the *Clavecin Électrique*, designed by the Jesuit priest Jean-Baptiste Delaborde in France, dates back to 1759[45] and Cahill's complex *Telharmonium*[46] was built in 1900, the *Theremin* and *Ondes Martenot* were the first practical instruments involving new technologies that found applications in various performances and compositions[47]. Their possibilities of glissandi and microtonal pitching, the compelling airiness of the sounds (close to a singing saw) and the expressivity of the style of playing (vocal-like vibrato and tremolo effects), reminiscent of the expressive qualities modelling the voice and acoustic instruments (especially the vibrato, dynamic shapes, timbral variation), are still striking features of these instruments. There is almost a tangibility[48] to the performance method, embracing the qualities of conventional acoustic instruments compatible with Busoni's demands.

The German electronic instrument maker Harald Bode highlights two distinct strands continuing throughout the development of electronic devices. Bode's "contributions straddled the two major design traditions of new sounds [i.e. the Warbo Formant Organ (1937)] versus imitation of traditional ones [developing tape based recording techniques] without much bias since he was primarily an engineer interested in providing tools for a wide range of musicians."[49] Whereas the early development of electric organs, as performance-orientated devices preempt synthesisers and tape techniques preempt sampling techniques, paving the way to make these recording techniques available for a 'true' imitation of acoustic instruments based on actual

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43 Developed by Lev Sergeyvich Termen aka Leon Theremin, 1928.

44 Developed by Maurice Martenot, 1928.

45 Dunn 1992, p. 22.

46 Dunn 1992, p. 23. Cahill's Telharmonium used electronic signals to control tone wheels amplified through horn speakers and employed telephone transmissions envisaging performances to be broadcasted to subscribers at their homes and offices. The idea and realisation were foiled as parallel developments in electronically based recording and broadcasting techniques were ignored. Furthermore the weight of approximately two hundred tons required a fixed installation of such an instrument into any concert hall.

47 Milhaud (Darius Milhaud: Suite pour Ondes Martenot (ou piano) et orchestre à cordes ou d' harmonie (1932)), Jolivet (Andre Jovilet Trois Poemes), Honegger (Suite for Film "Le Démon de l`Himalaya", 1935), Varese (Ecuatorial for bass voice (or unison male chorus), brass, organ, percussion and theremins (revised for Ondes Martenot) (text by Francisco Ximénez) (1932–1934)) and Messian (Fete des Belles Eaux (1937) and 3 petites liturgies (1944)).

48 Although in the case of the Theremin no parts are actually touched, the gestural control appears as tangible as the muscle memory can be employed in the same manner as with other acoustic instruments.

49 Dunn 1992, 28.

recordings (for example, in the digital age, samplers superseded the tape-based Mellotron).

Les Paul developed the electric guitar in the early 1930s by augmenting the acoustic guitar, notoriously problematic for its acoustic projection, with an amplification system . This augmentation increased the presence of the instrument influencing the development of popular music like no other instrument. The poor sound quality of early amplifiers caused guitarists to become accustomed to the distorted quality of sound when higher volume was required. In the second part of the 1950s, distortion, initially the accidental sounds of damaged equipment, became an quality of sound which was intentionally produced and explored, and by the mid 1960s distortion was established as a separate effect device, counteracting further developments in amplifiers which allowed a cleaner sound. Distortion can define the individual sound of the guitarist and genre, as is most apparent in the work of Jimi Hendrix, whose approach to the distorted guitar gave a sound to the political movements of the 1970.

1.3. Sound Source, Sound Manipulation and Amplification

At this stage, as preparation for the discussion of the *piano+,* it is necessary to emphasise the most fundamental principle of electronic sound production and manipulation. Electronic devices require a sound source, whether based on oscillators or acoustic/recorded sound, to supply fundamental sound characteristics, establishing the pitch of the sound (a sine-tone being the most reduced form of oscillation) or the noisiness of the sound (white noise forming the other end of the spectrum). A common second stage is a means of manipulating the timbral quality of the source, e.g. with some form of filtering. Amplification forms the third and final stage, enabling the transition of electronic signals into actual audible sound.

These three 'stages' are significant, because the entire history of electronic instruments and devices can be categorised within these areas and technological advances often focus on a singular 'stage'. However, it is impossible to describe a sonic quality which would be valid for all electronic instruments. Their diversity is reflected by the range of possible aesthetics and conceptual approaches, as well as controls and their mapping which is decisive for the interaction and form. Technology reveals itself as a tool to facilitate and enhance performance. Technology is part of the instrumentation reflecting contemporary concerns, but it cannot be the musical content itself.

Oscillators, wavetable, samples and algorithms can be the first stage for an electronic instrument as identified above (and schematically displayed in Figure 1.1). Microphones, contact microphones and pickups are the fundamental tools to use an acoustic instrument as the source for electroacoustic processes. What makes electronic and augmented instruments so different is how one can interact with them and how they maintain a close sonic coherence between source and modification. This is not only caused by capturing the sound of the acoustic instrument but also that it is possible to utilise existing controls (keyboard, strings, bow etc.) and all tactile instrumental properties. The technology, therefore, facilitates an augmentation adding to the acoustic properties of the acoustic instrument. In contrast, instruments based on oscillators or samples require a purpose built interface[50] to facilitate the control of all fundamental and subtle characteristics of the sound.

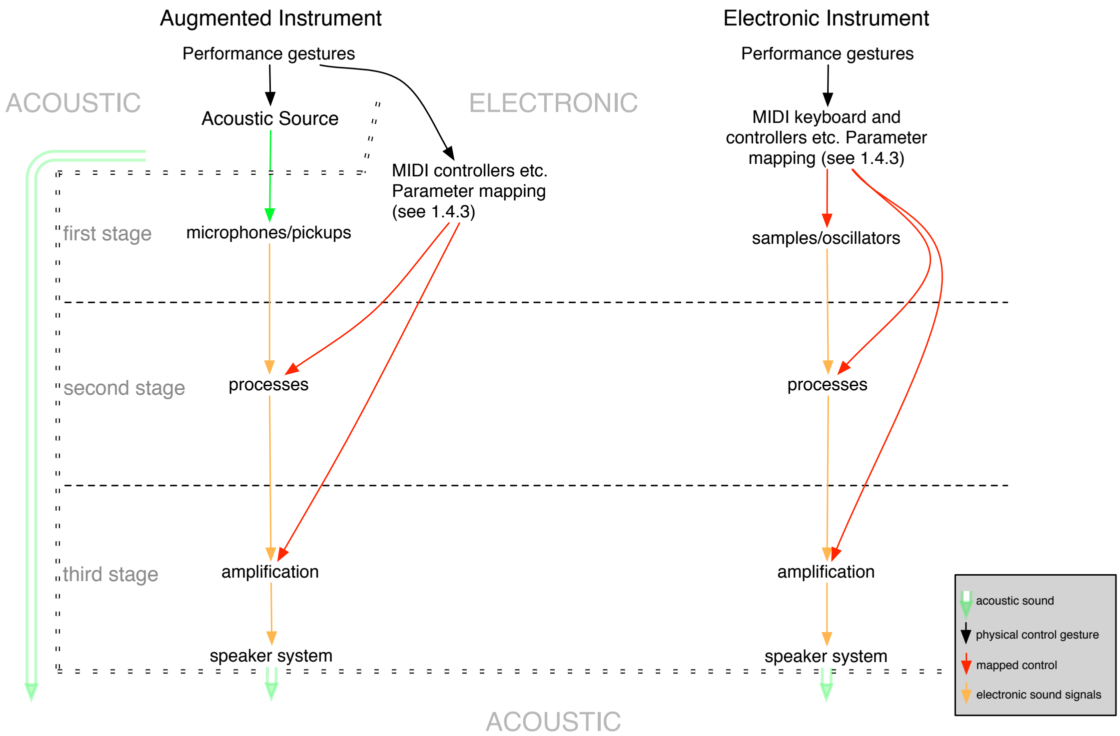

Figure 1.1: Simplified schematic outline of augmented instrument and electronic instrument. This figure is developed further in Chapters 2 and 4 (see figure 2.3 and 4.3).

[50] The concept of a keyboard has been most commonly adopted. However, 'commonly' should not mean that it is necessarily considered to be a wise choice. Alternative designs including the Hands by Michel Waisvisz (three versions dating 1984, 1989, 2005 http://www.crackle.org/TheHands.htm) or David Wessel's tactile device (Wessel 2007). Projects also have been adopting game controllers (e.g. Oliver, Pickles 2006 http://www.fijuu.com/) as well as tilt sensing technology i.e. WiiRemote controller (Berthaut 2010, Pearse 2011).

The second 'stage' within the signal flow of sound manipulation is more difficult to describe in general terms, as far more possibilities exist to vary the sonic outcome substantially (depending on the internal complexity of the processes involved). The relationship between the first stage and the second stage is complex and intrinsically related to each other. In the cases of augmented instruments a possible reduced and simplified methodology could approximate the relationship as following: if the sound source is capable of varied timbre, less manipulation in this second stage is necessary. The filtering employed with the electric guitar (e.g. settings of bass and treble), can be static during a performance as the expressiveness (i.e. timbral variability) of the sound originates in the actual playing of the instrument. The expressiveness of the sound of an electronic instrument can only emerge from a manipulation of timbre by changing filter settings with an implemented control structure. Similar fundamental relationships emerge when considering the third stage, the amplification, into the chain of processes. In this manner a manipulation of the amplitude can be static, to allow the changes in the first and second stage to be heard, or manipulated to create further sonic contours.

1.3.1. Defining The Source

John Cage has certainly been immensely influential in the development of new sonic possibilities (extended techniques, prepared instruments with objects), although his teacher Henry Cowell had already established the use of the inside of the piano. Very important to this discussion will be his compositional practice: to create a structural framework and layout which is ‘filled’ with sound events according to the intended process. This parallels the way electronics (and especially software) function, because the actual sound production is often independent from its amplification and perception: The oscillator of a synthesiser, for example, is constantly producing an oscillation, whether the result is audible or not. The use of radios in Cage's *Imaginary Landscape #4* (1951) highlights this independence of sound process and operational process. The radios transmit as soon as they are switched on, the frequency dial enables the performer to tap into continuous processes (the transmission, or the reception of ‘empty’ frequencies and sonic artefacts) and the volume control enables making these underlying processes heard – or not.

The use of the microphone, not to record but to amplify, has introduced various novel aspects into performance. These include the inaudible to be heard and to be used as a microscope for 'small' sounds, but also mixing techniques in live performances in order to balance instruments of different acoustic amplitudes.[51] In Stockhausen's *Mikrophonie I* (1964) the microphone, an audio capturing device, "becomes a musical instrument, influencing what it is recording"[52]. What is being captured can be manipulated in real-time, a technique not necessarily pioneered in *Mikrophonie I*. It also emerged some years earlier in John Cage's *Cartridge Music* (1960) where the performers employ microphones and phonographic cartridges[53] for their microscopic amplification of otherwise unheard sounds. Furthermore, within a few years various individual approaches were explored further establishing microphones and pickups as part of an extended instrument, as for example in David Tudor's realisations of *Variations II* by Cage (1961) in the years of 1961 leading to 1967[54]. In this manner the microphone and speaker do not act in place of the resonance body and its sound holes (or projecting surface), rather, they function more as agents: they are mobile, involving similar gestures to the conventional use of a bow, or the movement of the bell of a clarinet to direct the sound. Proximity becomes an expressive features of a performance.

1.3.2. Focus on Process

A growing interest in compositional processes becomes apparent in the second half of the 20th Century, often in combination with the composer/musician's conscious attempt to detach themselves from musical processes. The interest in processes also resulted in performance strategies within improvised music genres and subsequently developed in their own right thereafter. Obviously this causality also occurred reversed, so that improvisatory strategies influenced compositional approaches. I consider it particularly important that a long period of experimentation with the tam-tam he had installed in Stockhausen's garden preceded the composition *Mikrophonie I*. He finally settled on a scale of 36 sound characteristics defined by descriptive words that became basis of his compositional processes and score. The initially experimentations at the tam-tam were

[51] Emmerson 2007, 124-135.
[52] Maconie 1989, p. 80.
[53] Phonograph cartridges had been used by Cage as early as 1939 in Imaginary Landscape No. 1.
[54] Tudor's realisations of Variation II date from 1961 to 1967, with the most remarkable 1967 version released on Columbia, re-released on CD by Edition RZ.

recorded while his engineer improvised with the settings of filters independently. Interestingly he recalls that the recordings where “so astonishing [...], unbelievable, a great discovery. We heard all sorts of animals that I had never heard before, and at the same time many sounds of a kind I couldn't have possibly imagined or discovered, not in the twelve years I had worked in the electronic music studio up to the time of that experiment."[55]

Tudor developed performance strategies which transcend the concept of an amplified piano. He “employed the amplified piano, conceived as an electronic instrument”[56]. “Here it is a unified electronic instrument with its won characteristics that must be addressed in the realization.”[57]

In addition to the inclusion of sound capturing devices, feedback loops have to be considered as an instrumental feature as well, i.e. either the acoustic phenomena emerging when microphones and speakers are in close proximity, or signal loops within the electronics. Jimi Hendrix developed a distinct playing style utilising the feedback between the guitar and the amplifier as an expressive means rather than an acoustic disturbance. The principle of many electroacoustic processes such as filtering, delays and echo also rely on feedback loops within their algorithms[58].

1.4. Turning Digital

An overview of the proceedings of the ICMC (International Computer Music Conference) reveals a notable development over the years (from 1977 to present). Many papers dealt in the earlier years with concepts of electronic instruments intended for performance on stage involving live musicians[59]. By the mid 1980s, this approach seems to disappear from the main lines of research in favour of electroacoustic music and generative computer algorithms. There is a gradual return of performance concerns from the late 1980s onwards, investigating interfaces and other related topics. Arguably, this return reflects advances in computer hardware. These computers enabled an

55 Maconie 1989, p. 78.
56 Tudor quoted in Pritchett 2000.
57 Pritchett 2000.
58 Roads 1996.
59 Yantis 1977, 1980, Barlett 1978, Abbott 1980.

engagement with algorithmic processes like never before, but at the cost of the real-time process, because for many years computer systems were not fast enough for real-time music production and therefore required that pieces were created in dedicated studio environments[60]. Only the increasing CPU power from the end of the 1990s made sufficient processing speed available to be able to conceive of more complex performance systems that can run from an ordinary laptop computer. This made the development of such systems more practically viable for performers. The balance between the practicality of a system and available CPU speed will remain an issue for the foreseeable future. It is, however, a means to employ music studio technology as an instrument for live performance.

Consequently it is only since the end of the 1990s that computer based systems could feature an instrumentality that offers real-time sound manipulation suitable for extended improvisatory approaches. In some cases the use centres around extended looping techniques or elaborated DJing/remixing approaches in which sounds are sourced from existing audio recordings. The exclusive use of existing recordings as the source has been termed Plunderphonics[61] and situates itself in between DJing and sample playback.

Such approach to performance is widespread among laptop musicians[62] triggering prerecorded sound files and mixing them. The opportunity to apply real-time effects through plugins expands the possibilities. The computer made 'tape techniques'[63] realisable in real-time[64]. Combining the techniques soundscapes of various complexity can be generated and modified in an intuitive manner by accessing vast sound archives stored on the computer hard drive but also by utilising tape recorders, CD players and minidisk players. The additional opportunity to record an acoustic instrument or other sound-producing objects on-the-fly to add new material has developed a whole aesthetic

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[60] Max Matthew's first digital sounds required long processing times, i.e. stated in his foreword of Boulanger 2011 p. xi.

[61] Oswald 1985. There are questions concerning issues on copyright which is a sensitive area and carries much political weight. But, to remain within the realm of this discussion of technology, the focus is in the exploration of sounds, prerecorded independently at various locations and times, as well as existing musical works re-used as source material.

[62] Phil Durant, Janek Schaeffer and, Louisa Martin.

[63] Cutting and splicing tapes and rearrange and edit by rejoining the pieces of tape using adhesive tape.

[64] Ableton Live is a software facilitating this approach to laptop performance. Also interesting is the appeal of being able to have a laptop to contain the entire performance setup, avoiding additional hardware, and the reduced costs as several instances of processes can be employed without further investment.

in its own right[65]. Such approaches can be described as sound sculpturing[66], because the comparison to the plastic arts reveals much of its approach: Sounds are activated and 'set into motion', additional sounds and modifications are applied where they seem appropriate, as an artist applies changes to the sculpture during the creation of the work. Like the artist, who does not have to get physically involved in the existence over time, the musician is not involved in the continuation of the sound production. The 'sound sculpture' can perpetuate by itself, because continuous playback techniques are involved. Therefore the musician has gained the possibility to 'step back' from his/her sonic creation and passively observe, in order to develop ideas about appropriate changes to be applied. This mode of performing has a considerable number of advocates, and is also arguably closely related to the approach of DJs in clubs. Prerecorded sounds, textures, grooves, patterns pieces and so forth are arranged and layered to generate new textures from layers of various different samples and pieces.

1.4.1 Metaphors for Musical Control

Further relevant aspects to performance with computer systems are identified by David Wessel[67] which indicate their potential for expanded approaches. Four categories for working with computers are suggested: “Drag and Drop”, “Scrubbing”, “Dipping” and “Catch and Throw”.

> “‘Drag and Drop’
> use of ‘drag and drop’ is based on gestural interfaces with two-dimensional surfaces and accurate position sensing. [...] both musical material and musical processes as objects occupying an area of the surface.”

The mapping of the gesture to pick up a source sound, dragging it over the screen area to drop it onto a process is significantly different to any performance gesture within the acoustic world. This gesture is nowadays so familiar in the everyday use of technology that its significance might not be too apparent at first. But the possibility to take a sound and process it differently, i.e. taking a recording of a particular sound in order to manipulate the perception of timbre (via filtering, distortion etc.), location (reverb and delay), or in its consistency (i.e. granulation, splicer etc.) indicates that there is a process

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[65] Toop 2004.

[66] ‘Sound sculpturing’ ought to be differentiated from Axel G. E. Mulder’s work defined as ‘sound sculpting’, “Getting a GRIP on alternate controllers: Addressing the variability of gestural expression in musical instrument design,” Leonardo Music Journal, Vol. 6, pp. 33-40, 1996. Sound sculpting is an entirely digital controller approach, including data gloves, and virtually generated and altered shapes for visual feedback of the controller.

[67] Wessel 2002, 14-16.

available which receives its material within a performance gesture: the process is filled with content.

> "'Scrubbing and Its Variants'
> Sinusoidal, granular, and other models allow arbitrary time-scale manipulation without changes in pitch or spectral shape. 'Scrubbing' interfaces require controllers with very accurate detection of one-dimensional position; this position parameter maps to the time index of the sound model. [...]"

The scrubbing metaphor has similarities with a traditional bowing gesture but clearly relates to well-known DJ scratching practices because of the correlation of position (forward and backwards) and speed of the playback in dependence of the gesture. While this method is available in a DAW[68], in order to enable easier edit point locations, it has musical potential, as employed by various artists[69]. It must also be noted that this approach to the playback of prerecorded material is particularly suitable for the use of continuous data captured from tilt sensors and position tracking, as left to right tilting can be coherently mapped to start (left) to end (right) position.

> "'Dipping'
> In the 'dipping' metaphor, the computer constantly generates musical material via a musical process, but this material is silent by default. [...]"

This metaphor is considered here as the most significantly different approach to music performance when compared to those possible on acoustic instruments. It was preempted in Cage's *Imaginary Landscape No. 4* (1951) for 12 radios. There, the 24 performers set the frequencies and volume according to the score, without any control of the actual captured audio. The radio receives the frequencies independently of the volume setting. So the change of the volume is dipping into the broadcasts, which equally are transmitted independent of any aspects concerning the performance. This 'dipping' metaphor is significant to the concept of the proposed performance practice described in more detail in Chapters 4 and 5. Audio streams can be processed continuously – regardless of whether they are heard – while a separate process decides when to dip into these 'audio channels'. The sound process is therefore disjointed from the actual activity of 'opening' the audio channel, as the process runs independently from this activity it is not guaranteed that the opened signal is actually audible in that moment.

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[68] Digital Audio Workstation, e.g. Pro Tools, Digital Performer, Logic, etc.

[69] A list of artist would be speculative here, as it is based on the knowledge of the software an artist used and an interpretation of what was heard in a performance, which enables the informative guess that this tool was used.

"'*Catch* and Throw'
The 'catch and throw' metaphor involves the notion of selectively trapping musical phrases from an ongoing performance, transforming them in some way, and then sending these transformed materials back into the performance. Transformation of musical material is critical for this kind of performance; literal echoing grows old very quickly. [...]"

While 'dipping' is most significant within the perceivable aspects of the performance practice, 'catch and throw' is the most fundamental description of the application of electronics. Chapter 2 will elaborate in more detail how every aspect of the electroacoustic manipulation of sounds is dependent on the capture and playback of material within significantly different time frames, i.e. a few milliseconds when filtering, phasing and flanging, from approximately 50 ms to about five seconds to perceive a measured delay (echo). For any repeat beyond the five second mark a regularity becomes increasingly imperceptible, and in the extreme there is a complete disjunction between capturing and playback processes – usually referred to as 'sampling'.

A second important character of computer-based systems (and some equivalent processes made with analog electronic circuits) is the disconnection of the sonic outcome from any tactile and haptic properties of the instigating action. Keys and mouse controls do not alter in relation to the sound produced, which Wessel[70] outlined as a possible area of future work into the haptic properties of controllers.[71] There is no sense of tension, ease, hardness or softness, because neither changes the feel of material of the touched control devices, nor is there a sense of vibration as in most of their acoustic counterparts. The last point has been addressed in hardware featuring vibrotactile actuators controlled by the software. While the acoustic piano locates itself in an interesting middle ground because, although the tactile qualities of the piano keys do not change in relation to the music being played, the physical action is nevertheless accurately felt in the moment a key is being depressed. The point of resistance is clearly perceivable and a major indicator to evaluate the acoustic properties of the sounds produced, especially in softer dynamics resulting from softer touches. This point indicates when the action of the key releases the hammer to strike the string, i.e. from

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[70] David Wessel in talk at the NIME 2006 conference in Paris.

[71] E.g. Bongers 2004, Behrdahl 2008, Novint's Folcon game controller (http://www.novint.com/index.php/products) .

which point in the movement the performer has ceased to have an influence on the tone being produced and when the full scale of contingent behaviour will unfold.

1.4.2. Digital Music Instruments

Miranda and Wanderley[72] give a comprehensive list of developments in the area of new instruments – Digital Musical Instruments (DMI) – offering a conform terminology to allow a classification of different instruments. The relevant differentiation between augmented musical instruments, instrument-like gestural controllers, instrument-inspired gestural controllers and alternate gestural controllers, convinces, as it allows a gradual continuum from one to the other. Instruments do not necessarily fall into a single category but feature characteristics which can be described by these. For example, Impett's *Meta-Trumpet*[73] and Bahn's *Sensor Bass*[74] are exemplars of the augmented instrument category, where "the input device is often a sensor system capturing the physical gesture of the performer."[75] Conventional keyboards, or the Yamaha and Akai breath controllers for the use of synthesisers and samplers would be instrument-like, "that were modelled after the control surfaces of acoustic instruments"[76]. The *Video Harp*[77], *Light Harp*[78] and *Laser Harp*[79] are instrument-inspired controllers, "inspired by existing instruments or intended to overcome some intrinsic limitations of the original models, but do not attempt to reproduce them exactly"[80]. The *Lemur*[81], *Data Glove*[82], *The Hands*[83] and some more recent developments for touch screen devices[84] could count as alternate controllers, "which do not bear any strong resemblance to existing instruments"[85]. Research has also explored EEG[86] and EMG[87] to control electroacoustic processes and algorithms. The course of

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[72] Miranda 2006.
[73] Impett 1994.
[74] Bahn 2001.
[75] Tanaka 2000, 390.
[76] Miranda 2006, xx.
[77] Rubin and McAvinney 1988.
[78] David S. Brown http://www.oddmusic.com/gallery/om21300.html last accessed 16.12.2011.
[79] Bernhard Szajner 1980.
[80] Miranda 2006, xx.
[81] http://www.jazzmutant.com/lemur_overview.php last accessed 16.12.2011.
[82] http://www.vrealities.com/P5.html last accessed 16.12.2011.
[83] Waisvisz 1984.
[84] E.g. TouchOSC for iOS and Android devices http://hexler.net/touchosc/, last accessed 25.07.2012.
[85] Miranda 2006, xx.
[86] E.g. Miranda 2005.
[87] E.g. *BioMuse* (Tanaka 2000, 391).

this discussion will show that the *piano+* performance system is concerned with all these categories and that these are only relevant to the control aspects of the instrument. The *piano+* is therefore described as a *performance system* rather than an augmented instrument, because the *piano+* differs significantly from enhanced controls systems, like the Yamaha *Disklavier* for instance, which within the given characterisations should be considered to be an augmented instrument.

1.4.3. Parameter Mapping

The distribution of control data to aspects of the sound manipulation (parameter-mapping) is also highly significant. In the field of gestural controls, Wanderley[88] has been contributing major research over the past two decades. Nevertheless the relevant underlying concepts can be sufficiently termed as "one-to-one", "divergent" and "convergent" parameter mapping[89]. The one-to-one model implemented in the majority of software and hardware allows detailed control. Every aspect of the process can be accessed by graphical user interface elements (numbers, faders, menus etc.) and controlled independently. The performance aspects of systems can be enhanced by grouping several parameters to a single controller (divergent mapping) as, for example, usually implemented for the velocity controls of keyboards to mimic the complexity of the variants of acoustic sounds played in different dynamics[90]. Convergent mapping attempts to acknowledge changes to be dependent on various aspects simultaneously as for example the speed of a bow, exerted pressure and position of the string are simultaneous influences of the string sound.

1.5. Performance Characteristics

Wessel's metaphors for musical control and his strategies for parameter mapping indicate the intrinsic relationship between the design and the use of an electronic performance system. While there is arguably a case to consider working in a studio as a performance[91] in its own right, the resulting sonically and structurally determined piece

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[88] Wanderley 1998, 2000.
[89] Hunt 2000.
[90] Divergent mapping: e.g. velocity – the strength of attack – mapped to loudness (amplification), timbre (filtering) and contour of the sound (i.e. softer attack, sharper attack).
[91] Emmerson 2007, 25.

reduces potential performance gestures in front of an audience to a presentation and diffusion of predetermined material. Strategies to retain performance elements can range from adjusting the balance between different tracks in real-time, spatial placement and diffusion, as "choices of combination of largely 'pre-cooked' materials"[92]. Improvisatory approaches are possible and most certainly the performance will have elements of spontaneous adaptations. A considerable number of performing laptop artists are working within this area, with systems controlled by computer mouse and keyboard, and/or MIDI controllers, sensors etc.[93] The fundamental difference lies in the decisions taken at the 'first stage' – the source of sound material – which can range from simple waveforms (sine, noise), to the most complex, precomposed sound collections and constellations[94]. Algorithmic implementations enable further real-time control strategies[95] and aspects of machine intelligence[96] which by themselves do not necessarily improve spontaneity and sophistication of control layers. The possible discrepancy between performer activity and sonic complexity has been raised by several writers[97] and indicates that the design on the control level does not necessarily determine performance characteristics. The combination of electronics with an acoustic instrument might appear a solution, by combining the new electronic enhancements and sounds to the known gestural signifiers of the established instruments.

Combining the electronic with the acoustic only adds to the complication of the roles between performer, instrument and electronic sound. John Croft offers five useful paradigms of electronic sound in relation to live performance: Electronic sounds compare to stage design in theatres when approached as 'backdrop'. An 'accompanimental' role fulfils a functional purpose such as a bass line or harmonisation[98] and adds chordal/harmonic parts. The 'responsorial/proliferating' paradigm has an increased complexity and a direct impact on the structural design, so a dialogue between the acoustic and electronic would fall into this characteristic. His 'environmental' paradigm – "creation by electronic means of the characteristics of

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92 Emmerson 2007, 27.
93 E.g. Phil Durrant, John Wall, Louisa Martin.
94 E.g. John Wall: "I prepare fairly structured wavefiles intended for use within a genuine live situation" (Pinnell 2008 http://www.paristransatlantic.com/magazine/interviews/wall.html) .
95 Furtlogic (Furt: Richard Barrett, Paul Obermeyer http://furtlogic.com/node/98).
96 Machover 1992.
97 Incl. Emmerson 2007.
98 E.g. Casio keyboard accompaniment, Score following.

various acoustic environments'[99] – can have a significant impact on the reading and understanding of the music. This paradigm appears to differ from the others. The projection of sound and its relation to the acoustic instrument[100] is an additional concern relevant also for the other approaches he enlists. Most relevant within this discourse is the 'instrumental' paradigm: "the attempt to create a composite instrument". This paradigm stipulates that "the performer plays the instrument-plus-electronics in a way somehow analogous to the way in which she would normally play the instrument alone."[101]

1.5.1. Performativity and Contingency

Despite the achievements of research in this field in recent years, I was always drawn to David Tudor's electronic work as it demonstrates a coherent and convincing performative aspect. His own compositions, such as *Neural Synthesis #2*, involving electronics have an organic feel, which arguably originates from the extensive experience he had as a performer. He appears to have managed to develop instruments that lend themselves to a remarkable rich variety of subtleties in tone production. The dynamics and texture of sounds show a wide degree of variation and continuous relation which retain, or at least convincingly suggest, that the sounds are not only subject to some contingent element during their production but there is also a means to gesturally interact with these. Although there is the possibility that the contingencies in control results from, at least in part, the use of analogue electronic circuits, I would also see the nature of his interfaces as an important element. Tudor's circuits enables immediate interaction by means of instant adaptation and adjustments but also sufficient interferences to allow contingencies in the sound production.

Contingencies will be discussed within a variety of contexts and perspectives in the following chapters, for now it will be sufficient to elaborate briefly on the potential contingent elements in musical performance. Contingencies are to be found within the balance of control and unexpected sonic outcomes. Specific control is replaced by intent and elicitation: the control structure allows to aim for a certain sound and the result is reciprocal to the executed gesture. If repeated, the result would never be a carbon-copy

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[99] Croft 2007, 62.
[100] See section 2.3.2. for further discussion.
[101] Croft 2007, 62.

of itself, because it would contain a degree of deviation. The scale and complexity of these deviations is clearly related to the differences between the gesture (e.g. speed and velocity).

The degree of general flexibility, potential for instantaneous adaptations and adjustments within any given performance system is one of the most crucial aspects within forms of music making that have a freer approach to musical content and are less structurally determined. This recognises that performative activities on acoustic instruments involve a continuous and instantaneous adjustment of a sheer unlimited amount of parameters, such as strength, position, speed, ... mostly defined through the technical skills of the performer to engage with the instrument.

It is therefore not surprisingly that Croft continues to stipulate “conditions for instrumentality”[102], which demand the computer instrument’s response “must be proportionate to the performer’s action”[103] and that it “must share some energetic and morphological characteristics with the performer action”[104], as well as featuring a “synchronous” onset. These points certainly have their validity in relation to electronic instruments. But to demand synchronicity – when considering augmented instruments, – appears to be less important, because the acoustic sound always links to the performance gesture. The electroacoustic augmentation might be perceived as a development of the acoustic decay phase of the sound. Omitting the relationship between acoustic sound and electroacoustic modification during the sustain and decay periods of the acoustic sound also gives a polemical twist to his request that there “must be a timbral continuum, affinity, or fusion between the untreated instrumental sound and the response of the electronics”[105]. But Croft has compelling reasons to draw attention to “purified” instrumental relationships. It highlights the widespread problem to find satisfaction in elaborated sound creations as a means to enhance the spectacle of performance rather than to explore the relationships.

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[102] Croft 2007, 64.
[103] Croft 2007, 64.
[104] Croft 2007, 64.
[105] Croft 2007, 64: To complete Croft’s list, he also urges to consider:
- The relationship between the performer and the computer must be stable
- The relationship must be scrutable
- The relationship must be learnable by the performer
- The mapping must be sufficiently fine-grained.

Croft's paradigms can assist in defining an informed opinion and help to evaluate existing works, but they can replace neither a continuing investigation of a relationship between the acoustic and the electronic nor a scrutiny of the role and purpose of electronics in society. The experiments with lo-fi electronic devices, novel control gadgets, as well as the application of sophisticated algorithms for audio analysis, networked performance systems and generative sound modification have validity. But scrutiny about their purpose ought to be in place too: So many times they only show that one can employ such technologies. They exploit the novelty factor for a shallow spectacle alone, thus the age of the technology becomes a criterion for the evaluation of the musical result.[106]

Although Alvin Lucier's sine-tone[107] pieces use simple technology they manage to establish an intricate and fragile relationship between the acoustic instrument and fixed tape playing slow sine-tone sweeps. The listener will experience that the fascination with technology is not necessarily linked to complex algorithms and modifications. This resonates in Croft's conclusive remarks:

> In our well-intentioned search for reliability and repeatability, perhaps we forgot what performance meant, and development ran ahead of poetics to create an impressive (if still unreliable) array of score-following algorithms and a multitude of remarkable (all too remarkable) transformations. But perhaps we need to step away from all this. It is inevitable that aesthetically pertinent 'liveness' involves relatively simple relations between input and output."[108]

The role and purpose of technology will be thematicised in more detail in Chapters 5 and 6, but throughout this discourse implicitly stated and also more explicit references will highlight social and political concerns where seen appropriate.

1.5.2. Sound Sculpturing and Live Electroacoustic Music

With the focus on the use of electronics within live performance, where a conscious exclusion of detailed preconceived and prepared structure allows the music to develop in response to the momentary situation, feeling, ideas and intentions, it appears striking that a choice of the standard computer interface, which restricts its interaction to a number of binary keys and a mouse cursor in combination with some clicking methods,

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[106] This point has been made in various shadings, on one hand that the *piano+* always seems to features the latest technology as ipod touches are used for remote control of the laptop, as well as the surprise that 'old' processes such as FFT based analysis tools are still in use.
[107] E.g. *Still Lives* (1995) by Alvin Lucier.
[108] Croft 2007, 66.

has a direct influence on the musical discourse in a performance. To perform with a computer system depends on the execution of a series of key-strokes and mouse adjustments. Unless appropriate presets were defined and implemented or preconceived sequences and macros are made available, attempts for more complex simultaneous adjustments might be frustrated by the limited forms of interaction. Within this one can find the reason that many electroacoustic improvisations (EAI[109]) focus on drone exploration and slowly evolving sound textures, suitably creating, exploring and presenting their works in the vein of minimalistic and reductionistic musical concepts. It is certainly most inappropriate to devalue such laptop performances by assessing only the mode of interaction, especially as the technology allows the investigation of musical and acoustic phenomena of minimalist nature. The ability to explore the perception of minute changes requires a forms of listening which is not concerned about any gestural information, as in fact it would be impossible to execute by any acoustic means, due to human error – the inaccuracies of repetitions and gradual fatigue in the physical activity over time.

As technology allows a disconnection of sound production and physical gesture, the concept of ‘sound sculpturing’ becomes possible. The performer can create a sound texture, step back and observe the proceedings as an artist can step back from the canvas or sculpture to reflect on the work, in order to possibly engage with it to make small changes which will tweak the course of the performance. This is a quality that yields much potential and in many ways employs technology for what it can do best. In this manner one could assume that the attempts to humanise technology, to make it resemble the qualities found in their acoustic counterparts is a futile undertaking. However, performance practises have evolved within this field with countless differences in approaches and concerns, while from the musical result alone it is possible to see a connection between the early tape pieces by Steve Reich and drone based pieces slowly evolving over long periods of time, a shared motivation cannot be assumed. The meditative character of the didjeridu might only inspire through the timbral continuity rather than its potential to serve trance-like states of mind.

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[109] An abbreviation which appears to establish itself as a term to describe a genre of music incorporating aspects of electroacoustic music and free improvisation. http://en.wikipedia.org/wiki/Electroacoustic_improvisation.

This overview has explored how many electronic music devices and performance systems have developed out of an individual music practice. They result from similar musical and performance related approaches and concerns not necessarily documented and most certainly not subjected to defined and consolidated developments. While electroacoustic composition "continue[s] to strive to create music in which timbral development [is] the guiding factor [live electroacoustic performance] use[s] whatever means [are] available to explore the nature and/or role of performance within electroacoustic music"[110].

The processes and procedures for sound sculpturing and live electroacoustic music are very similar, if not even identical. It is the musical approach which is the decisive factor between the two and to overcome some of the discussed limitations the latter most would require a more sophisticated and complex controller system. The most salient aspect of this overview, however, is to highlight the increased relationship of individually developed instruments and performance tools and its resulting musics. The means of manipulation – the flexibility and the adaptability of its tools – chosen to evoke and interact with the sound production is often unique and directly linked with the artistic objectives. It has to be noted, however, that there is a direct and intrinsic causality perceivable in the music: its timbral, rhythmical and structural character reflect the flexibility and the adaptability of the instruments used.

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[110] Eigenfeld 2007, 1.

Chapter 2: Towards the Instrument

The role of the instrument plays an decisive part in the context of a performance practice thesis. Although a particular instrument might be associated with a specific music style – as the saxophone is closely connected to jazz, or the tanpura to Indian traditional music, the reverse does not apply: Instruments are not restricted to a particular style, e.g. traditional instruments might see a revival in new music[111] and music is being arranged to suit for new instruments. Instrument facilitate the production of sounds; their design allows the manipulation of the sounds in pitch, timbre and dynamic range. Electroacoustic processes – effects, synthesis and sampling techniques – allow such manipulation too. Therefore, an outline of some principles of sound is considered appropriate, in particular to develop a conceptual reduction of electroacoustic processes as a means to modify sounds in presence, location, timbre and duration. Sonic modifications and the underlying structure and approach to interact with their parameters are fundamental to give appropriate control over electroacoustic processes and have consequences for the social aspects of music making.

2.1. Properties of Sound

When we hear a sound, the ear drum senses differences in air pressure emitted from the acoustic source. We hear the sound from various directions at any moment in time: the sum of direct sound and the multiple reflections. Reflections lengthen the time sound waves require to reach the listener's ear in relation to the direct sound waves. These minute modulations of the sound waves in the acoustic environment are perceived by the ears and processed to create a mental interpretation of the surrounding environment and to locate the position of the sound source. This abstraction of sound to its physical properties indicates the absence of particular meaning of sounds themselves, because the physical conditions of sound perception is not given any further possible carriers and codes. The complexity of interpretative element for the coherence and meaning of sound in the listening processes is significant: Sounds need to be interpreted, in a truly

[111] For example the use of flute, violin, accordion being employed within Rock styles.

fundamental manner to distinguish danger from safety[112], as a carrier for language and as an opportunity to engage in 'simulated' environments such as music. The act of listening to music deals with acoustic phenomena which are interpreted in acts of conscious reflection and analysis. Considering the biological importance of hearing, the argument that music activate unconscious reactions seems very plausible. Intuitive response to the aural stimulus is crucial for survival. The possibility of disconnecting the intuitive responses is a conscious act in itself, i.e. overriding possible intuitive responses as the listener knows and trusts to be in a safe listening environment while listening to music.

The evaluation of sound is intrinsically related to our experience as the cultural environment and personal experience contribute to the perception of sound. A major aspect how we hear and recognise different sound sources is how the amplitude of the partials (frequencies) change over time. The sound can only be analysed by its physical compound of frequencies in the spectrum, and how these develop over time. An unknown sound construct can have unexpected emotional responses, because the actual construct and development of the frequencies differs so significantly from anything one has ever experienced.

When asked about new strains in improvisation, Evan Parker responded with respect to deliberate attempts of inventing new sounds: “I'm not very interested in somebody trying to shock me. That can't be done any more (smiles)”[113]. Does this imply that after a long-term involvement with experimental forms of music making the possible emotional responses of surprise diminishes, thus the individual experience altering the potential perception?

Hüther’s research[114] stresses the importance of learning processes in the development of the human brain in an attempt to prove that the brain is capable of continuous change throughout life. He indicates that much less information is passed on through DNA as

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[112] Low frequency rumble noises behind a person would by association be interpreted as danger, while high frequencies above somebody would indicate safety. However, different environments might require different associations and interpretations as personal experience has shown when sounds of the Black Forest have been misleading indicators of the actual environment while hiking through the sub-tropical forests of Pingtung County in the south of Taiwan.

[113] Interview with Even Parker by Dan Warburton, 30th January 2010, available on paristransatlantic (http://www.paristransatlantic.com/magazine/interviews/parker.html) last visited 14.09.2011.

[114] Hüther 2006.

other research suggests. As a consequence, the highlight is on the early age learning, especially during the embryonic stages and early childhood. Learning processes predate our conscious memory of events and indicate the importance of the auditory environment, as it has been suggested that embryos hear from the 8th month of pregnancy, however vibrations are 'felt' from much earlier. This would suggest that listeners might feel drawn or repelled by certain sounds because of experience, even – or especially – if these are unconscious.

Statements like these give support to the standpoint that music can only be truly 'created' in the head of the listener. The physical properties of sound are consistent. Perception of pitch relates to a dominant frequency (fundament) in relation to weaker harmonics in the frequency spectrum. Timbre is the distribution of the harmonics in relation to the perceived fundamental. Our aural sense can be trained, the acuteness of the sense, the scope and accuracy of our interpretations of what we perceive can evolve. The same applies to the perception of the spatial properties of sound sources, which is essentially a construct of our brain. The cognitive processes are, an interpretation of the acoustic space, through sensing time delays between the ears and perceiving the filtering effect caused by the shape of the head and ears[115].

2.2. Extended Sound Properties of the Acoustic Piano

The acoustic piano has a considerable sonic complexity due to its fundamental design. The size of the resonating surface area and the high number of strings is unique when compared to other stringed instruments. Each string produces the fundamental frequency and its characteristic distribution of harmonics which develop over time. The onset (the spectral shape of the moment the hammer strikes the string) shows a very rich frequency spectrum[116], but rapidly reduces to a smaller number of partials which consolidate the perception of the pitch and defines its timbre. Using the sustain pedal to lift the dampers from the strings of the piano causes sympathetic vibrations. This

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[115] For a very brief overview of the more recent research in this field see Purwins, Hendrik; Hardoon, David R.. 2009. Trends and Perspectives in Music Cognition Research and Technology. Connection Science. 21(2-3), 85-88., also Sloboda 1985.

[116] The more the spectrum diverts from particular relationships between the frequencies, the noisier a sound becomes. In its most extreme, white noise contains all frequencies in random amplitudes. The instrument is defined and identified by the balance between the different partials defining the timbre.

increases the depth of the sound and makes it appear more distant, especially in the latter part of its decay, as some partials are prolonged by other strings. These sympathetic vibrations are in some respect comparable to the resonances of a room, although the modulation of the sound is dependent on the tuning of the strings rather than the architectural design of the room.[117] Extended playing techniques can focus on these complexities in various ways, e.g. various piano works have utilised these properties of the piano by silently depressing selected keys (e.g. Cardew, Parsons, Rzewski), preparations which manipulate the partial content and their decay (e.g. Cage) and varying the method in which the string is stimulated to vibrate (e.g. struck by the hammer, struck by a different object, plucked, bowed).

2.3. Electronic Augmentation

Electronic devices can be deployed for sound production – sound synthesis – where no other sound source is required. They can also be used for sound manipulation of other sound sources. This thesis focuses on the techniques to augment an acoustic instrument, therefore the means to modify sound with effects is more important in this discourse, although some processes utilising synthesis and sampling are also discussed in Chapter 4.

2.3.1. Fundamental Properties of Electronic Augmentation

Sound manipulation, more commonly referred to as effects, can be plotted within a fictional three dimensional space. Whereas the vertical describes the timbre (we can allow the concept of a frequency distribution from low to high), the horizontal refers to time [118], and the perceived distance of the sound is marked on the z-axis.

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[117] The industry has recognised this to be the major factor and problem to recreate a convincing electronic imitation of the piano and much efforts have been made to develop suitable algorithms to imitate this acoustic property. Essentially these developments utilise the same technique as artificial reverberation, although the elongation and phase relationships are more difficult to recreate as each string contributes individually to the resulting sound.

[118] The idea of plotting sound manipulations in a graph shows distinct similarities of Wessel's "timbre spaces" (Wessel 1979). The x-axis represents the timbre in both cases. The y-axis relates to time in the sense of envelop shaping the synthesized sounds while here the time relates to a delay factor of the current sound.

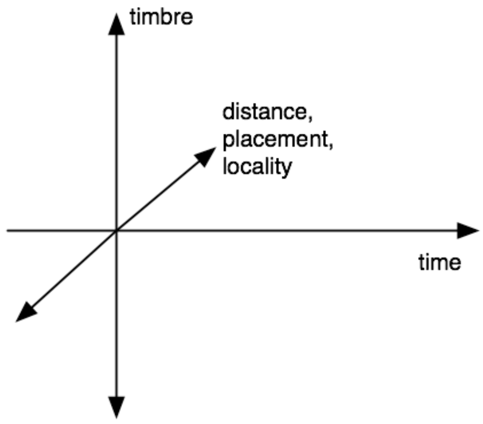

Figure 2.1: Abstraction of sound properties plotted in a three dimensional graph.

The third dimension is slightly more conceptually derived in relation to the timbral content and time development, as our brain computes the spatial distance of a sound by interpreting the reflections (time replacement), resonances (prolongation of specific frequency ranges) and filtering (due to sound absorption and the differences in dissipation). The resulting sound is therefore a subtle alteration and modulation of the source. In consequence, the electronic sound modifications can be looked at in similar terms and divided into three main categories:

- replacement of a sound in time: delays
- altering the frequency spectrum: filters (reduction of frequency content or enhancement of frequency bands), transpositions (shifting frequency content), and adding to the frequency spectrum (i.e. ring-modulator)
- spatial placement, either utilising sound projection and diffusion techniques or utilising electronic imitations such as artificial reverb.

Performers can manipulate and contribute to the frequency spectrum by using acoustic and electronic means. The electroacoustic processes also add to the frequency spectrum by time replacing sonic events and processes which in- or decrease certain areas. Figure 2.2 shows an example where short percussive hits from drums and piano are prolonged (filled) through time based electronic processes. The visual representation of the frequency spectrum does not reveal anything more than which frequency (y-axis) are audible (gradient of grey/black: amplitude) and how they develop over time (x-axis). It is only through audition of the recording that one is able to analyse that due to the recording approach itself the electroacoustic processes appear in this instance more distant which corresponds in decreased intensity of the grey.

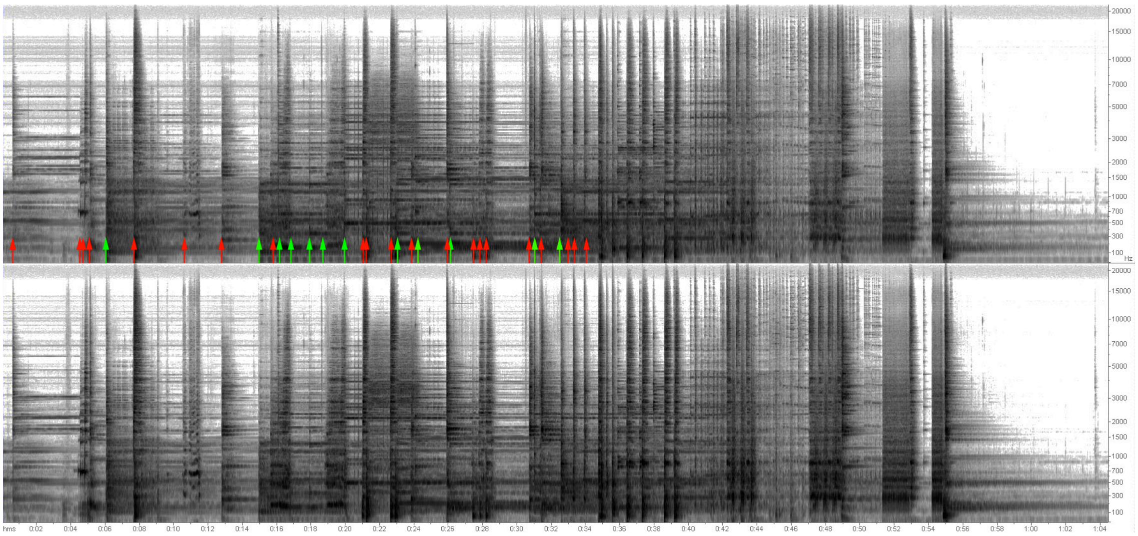

Figure 2.2 A spectrogram of the Lexer/Noble duo (2011-10-25_LexerNoble.wav minutes 8:32 - 9:28). For the first half of the figure the arrows in red indicate drums hits, the green short piano sounds, in between these the density of the spectrum results from the real-time processes time-replacing the acoustic material.

To reduce what is perceived during a performance to the physical properties of sound focuses on the fact that the ear only perceives periodically changing air pressure. We disconnect the theoretical discussion from specific electroacoustic processes used and remind us that perceived sound is the addition of all the audible frequencies which require time to evolve and reveal all necessary properties to be interpreted by the listener. This is a theoretical exercise which is considered helpful for this discourse in order to introduce a perspective on electronics required for Chapter 5 and Chapter 6.

2.3.2. Amplification, Filtering and Placement/Locality

Technology offers various approaches to influence and alter the components of sound[119]. In essence, amplifying the sound changes the amplitude and with this can alter the perceived distance as well as make otherwise inaudible characteristics audible. While amplification usually attempts to leave the acoustic character of a sound intact, different types of microphones might affect the colour of the sound and offer musical characteristics[120]. Technology also offers different techniques to work on the distribution of the audible partials by selectively enhancing and reducing frequencies in the overall spectrum. The placement of amplified sound is dependent on the speaker system in relation to the acoustic instrument and the balance in volume. Both aspects

[119] The reader should be reminded of the conscious exclusion of synthesis at this stage.
[120] Emmerson 2007, 124-134.

are fundamental to the perception of the augmented instrument, because electronic processes are utilised simultaneously to producing sounds on the acoustic instrument.

Each technological process [121] is essentially non-discriminate about the nature of the acoustic signal captured through a microphone. The dynamic range can be of issue because, for example, heavy amplification to make small sounds audible might make louder sounds unbearable and cause unintended feedback or distortion. The obvious strategy is to ensure a spatial separation of sound source and speakers to minimise the possibility of feedback. But this generates an instant dislocation of the sound properties and changes the presence of the instrument in the space[122]. In the case of untreated amplification, the instrument is perceived in increased proportions particularly when the amplified sound is projected through a conventional PA setup, where speakers are placed on the sides of the stage. The location of the instrument might not be discernible aurally resulting in a spatial omnipresence. When captured signals are treated in some form, the perceived audio image is distorted spatially, as a distinct distance between the location of the acoustic instrument and the electronically modified signal emerges. This spatial discrepancy is commonly rectified by mixing both the treated and untreated signal onto the speaker system, which arguably brings the two qualities together to be perceived as one. These issues of omnipresence and dislocation of the acoustic and electronic source have to be accepted and dealt with on an individual basis. There is no intention to suggest a general rule, but it is considered important to be aware of the consequences that decisions on the basic setup might have on the performance itself. Especially in performances combining acoustic and augmented instruments considerations ought to be given on the means how “local control” can be effectively “reclaimed”[123]. A hierarchy in the ensemble might already appear due to an omnipresence of a single instrument preventing more intricate relationships simply because one instrument overpowers the others.

It has to be acknowledged that with an attempt to refrain from creating inflated acoustic omnipresence one will face issues of the acoustic source masking the electronic

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[121] This discussion is closely related to considerations within the performance system *piano+*, however there is a wider and more general relevance to the use of electronics within live performance.

[122] It is in this context that Croft’s ‘environmental’ paradigm (Croft 2007) appears to have more relevance: While issues might arise from sound projection in performance, sound diffusion is a compositional tool for electroacoustic music.

[123] Emmerson 2007, 95 (from footnote 16).

processes. Filtered signals, for instance, will always have less energy and are therefore perceived to be softer, as they consist of fewer frequencies than their acoustic source. Filtered signals would have to be amplified or a separation to the acoustic instrument would be required in order to avoid the acoustic sound masking the electronic. When speakers are located close to the instrument, an increased danger of feedback can be an issue; moving these further away increases in turn the dislocation between the acoustic and the electronic. In the same way that a player in an acoustic ensemble has to judge her/his projection in relation to the others, the player of an augmented instrument has to consider both elements. Emmerson cautiously suggest the term “control dislocation” in this context where the performer looses the overall ability to control and judge "the overall effect of the electronics" and allow an “awareness of timbral nuance, level sensitivity and inter-performer balance"[124].

The performance system *piano+* focuses on solutions to keep the fundamental acoustic qualities and spatial presence of the piano intact, in order to preserve and explore the relationship of this augmented acoustic instrument within ensemble performances. This approach originates from a fundamental concern about emerging hierarchies which are caused by the use of technology, rather than the social activity within the ensembles. A setup was envisaged allowing – or demanding – players to be aware of their role in the ensemble and to be responsible for their sounds and balance within the ensemble. It avoids an approach where individual responsibility has been transferred to a separate person creating a suitable mix at a console. Other considerations also included aspects of practicality, e.g. to have a minimal performance setup.

2.3.3. Time Replacement

Time based processes create a delay between the source sound and its modified version. Due to the time displacement the considerations about amplification, masking and projection can differ. A simple delay line decouples the electronic sound from its acoustic source, which increases the differentiation and perception of, for example, filtered sounds. The duration of the delay can vary significantly as the process is based on recording the source. It is therefore only a question of how long the recording is stored before it is played back. In fact, electronic effects processes such as phasors,

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[124] Emmerson 2007, 95.

flangers, delay lines, and sampling techniques only differ by the time passed between original and 'copy' and if the delay time is constant or being modulated. In the case of sampling techniques the time delay is not based on a set time, but on separate triggers for recording and playback. Although there is the clear connection on a technical basis, each of the processes has its own idiosyncrasies. If automated time intervals between capturing sound and playback are abolished, the process changes from delay lines to sampling: the process of recording, storing and retrieving sound. It is then necessary to implement specific concepts to organise and deal with the recorded material. These might involve to select and trim excerpts of a recording, storage, categorisation and approaches for sample retrieval. These activities often have to be considered as 'operational tasks' as they only prepare a possible use of the sample in performance. When a performer has to engage with such tasks during a performance, they ought to be distinguished from 'performance activity' which results in audible events.

2.4. Operational and Performative Activity

A distinction of the activity by a performer engaging with electronics ought to be made especially in context of simultaneously performing at an acoustic instrument. Playing the acoustic instrument involves mainly 'performative activities': a performative gesture has an immediate audible result or a perceivable influence on a continuing sound. In contrast an 'operational activity' constitutes an action which is essentially inaudible and of a preliminary nature, or at least not intentionally contributing to the sonic development of the current moment. Godlovitch discusses "causally implicated"[125] activity in performance in the context of using "modulators" for electronic processes[126]. Although this term would also be suitable in the context described here, as there is no direct causality between activity and an immediate sonic result, it is considered beneficial to focus on the preparative tasks and the execution of a sonic event in performance. Therefore, "operational activity" is not only referring to the handling of a machine. Changing the tools to play the strings of an instrument has also operational qualities, such as for example picking up and putting down a bow. "Performative activity" is equally not exclusive to the acoustic. Triggering samples or processes are

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125 Godlovitch 1998, 25.

126 A sequencer would be a form of modulator. Generative approaches would also qualify as modulators.

performative, as well as, for example, the audible adjustment of a cut-off frequency to create a filter sweep.

However, it is argued here that “operational tasks” occur more frequently while performing with electronics compared to playing an acoustic instruments. Electronic devices enable the execution and automation of musical processes without direct physical involvement. Operational tasks are necessary to prepare changes to processes. To deal with dialog boxes in the software to make necessary changes (e.g. selecting an affect process from a list of plugins etc.) and to change preset parameters prepared to tweak and adapt the process. The resulting texture can be independent of this activity, as it can run on its own through automations and the modulations on the process are only audible at a later time. Continuation of sound of an acoustic instrument is directly linked to physical activity. In consequence one ought to take into consideration that operational activities might interrupt the performance activity and might therefore have an influence on the acoustic contribution. To execute an operational task one might need to free a hand to attend to the electronic device and touch a controller (or aim to a parameter with the computer mouse).

As it is a fundamental feature of the technology that processes can run independently of physical activity, signals can be processed continuously and accessed in the methods described in Chapter 1. For example, “dipping” would be a performative activity; adjusting the actual process used would most likely be an operational task.[127]

2.5. The Infrastructure – General Structure of the Augmented Performance System

The ergonomic design of the piano does not necessarily accommodate additional controls. There are several approaches, including MIDI pianos[128] and the piano bar[129], which attempt to turn the piano into – or augment it by – a MIDI controller. The benefits of a direct correlation between playing the piano keys and digital data available for the control of electronic music systems is apparent: processes can easily be triggered

[127] It might also be worth elaborating the effects processes silence or sound, i.e. the performative activity on the instruments determines the audible result of the process.

[128] E.g. Yamaha *Disklavier* http://usa.yamaha.com/products/musical-instruments/keyboards/disklaviers/

[129] Product developed by Moog, seems to be discontinued, description: http://www.soundonsound.com/sos/mar05/articles/moogpianobar.htm .

and controlled simultaneously to acoustic sounds being produced. However, the data transmission is dependent on conventional playing styles[130] and unfortunately inadequate when extended piano techniques are applied.

A computerised performance system augmenting an acoustic instrument comprises the following key components:

- audio capturing (see 2.5.1)
- audio processes (see 2.3)
- control structure and parameter distribution (see 2.5.3)

These components would, for example, be implemented in software in the form of a potentially complex but easily adjustable system. This also requires a strategy for control the of necessary parameter changes, or as Fiebrink states: "the relationship of gesture to sound must be intentionally composed"[131].

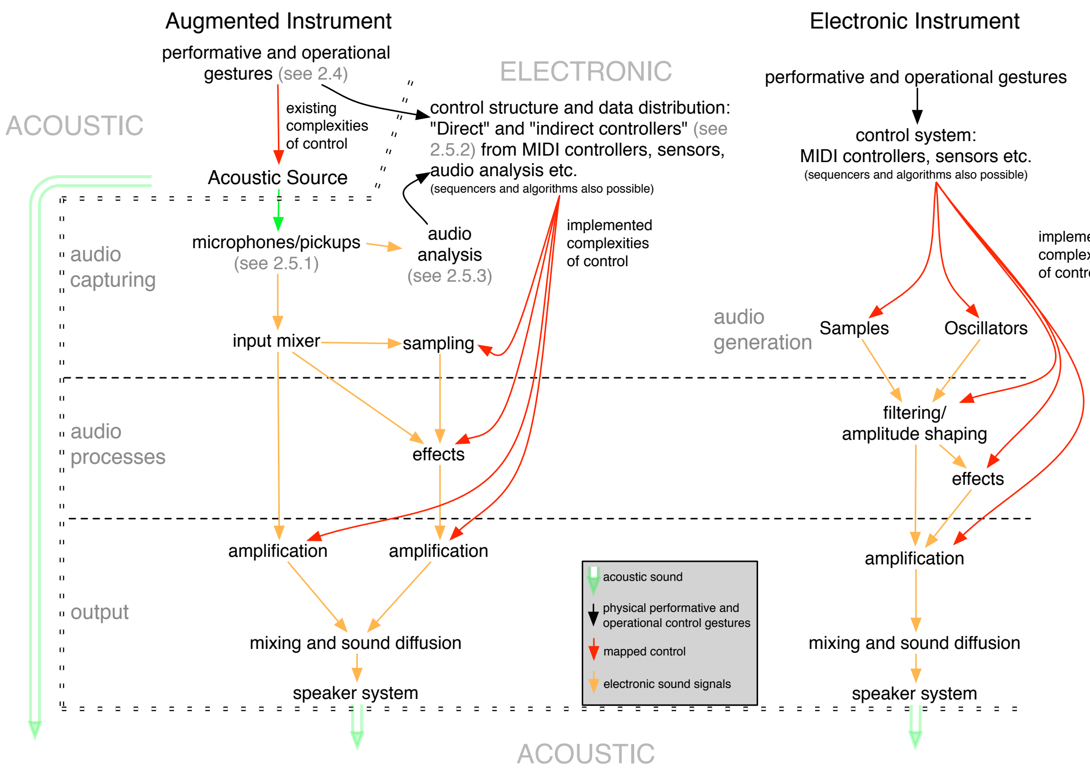

Figure 2.3 Schematic outline of an augmented instrument (based on the simplified Figure 1.1). For comparison a schematic of an electronic instrument has been included to show the difference in the control. The electronic instrument solely relies on the implemented complexities of control while the augmented instrument also 'inherits' the existing controls of the acoustic instrument.

Although the outline given in Figure 2.3 has general validity for augmented instrument design, the components and control structure would differ significantly according to the

[130] Use of the Moog's Piano Bar by Leon Michener www.leonmichener.com .

[131] Fiebrink 2010, 2.

intended functionality of the program. The actual implementation has direct causal implications on the performativity of the augmented instrument. While it might seem appropriate to make suitable tools available for all eventualities[132], the complexity of control increases proportionally. Developing an augmented instrument becomes a compositional process attempting to find a suitable approach and balance between design and instrumental possibilities.

There has been extensive research into the concept of “composed instruments”[133]. “The term of the *composed* instrument underlines the fact that computer systems used in musical performance carry as much the notion of an instrument as that of a score, in the sense of determining various aspects of a musical work.”[134] The score is immaterial in particular when considered as an outline of the instrumental possibilities. It represents the relationship between gestural controls and sonic outcomes as “musical instruments became dematerialised”[135] and the link between gestures and sound individually established by the program design with its implemented complexities of control.

2.5.1. Audio Capturing

Aiming to develop an augmented system independent from a MIDI-fied version of an acoustic instrument requires the use of microphones. The discussion focuses on examples around the piano, as this thesis reflects practical research with acoustic pianos, rather than more general and universal approaches. The author is confident however that the insights are transferrable to many other instruments[136].

In respect to the issues of amplification described above, compromises between sound separation and sound quality have to be found. Contact microphones (e.g. C-ducers) attached to the sound board give high level of acoustic separation during ensemble playing and help to avoid feedback, but the sound quality inferior to close-miking the piano with high-quality condenser microphones.

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132 Fiebrink 2010, 4. In the evaluation of the Wekinator users pointed out the importance of “reducing barriers to speed and ease of exploration”. While this already an important aspect for composers, it appears even more crucial for improvising musicians.

133 Wanderley 1998, Schnell 2002, Fiebrick 2010.

134 Schnell 2002, 1.

135 Schnell 2002, 1.

136 Experiments involving John Butcher on saxophone autumn 2008 and summer 2009. Short session included on Data DVD 2008-10-31_ButcherLexer.wav.

Inspired from the early live electronic works by Cage, Davies and Stockhausen, the concept of moveable microphones can be adopted (e.g. small lavalier microphones) to focus on small sounds and allow increased separation from other instruments. Guitar pickups can also be considered on instruments with steel strings; these offer maximum separation from other sound sources.

2.5.2. Control Structure and Parameter Distribution

While the audio processes included in an augmented performance system can vary widely and will contribute fundamentally to the sonic quality and scope, any design will rely on an accessible control structure, unless more compositional approaches of sequenced or generative structures are employed. At first it might appear desirable to allow convenient access to every parameter available in the system. The previous discussion on operational and performative activity has already indicated that such an approach might have a negative impact on the flow of a performance, as audible changes to processes might require adjustments of several parameters (operational tasks) to invoke a single intended change in the music. Not all electroacoustic processes can be controlled as effectively with a single performative gesture as the example of the filter sweep executed with a single controller (i.e. MIDI fader). The implementation and use of controllers has a direct relationship to the musical outcomes. Implementing direct control for every (or at least every musically significant) parameter allows maximum of adjustability, but might impact the practicality and performability of the system. MIDI controllers are easily implemented for direct controls for specific parameters. Custom build controllers[137], optimising the layout design of the controls, might be developed as instruments in their own right[138] or improve use in combination with acoustic instruments.

A slightly different approach is apparent in works focusing on sensors to capture performance gestures: In order to avoid designing a system which requires additional control activity, the gestures of playing the acoustic instrument are tracked and its data interpreted in order to generate relevant control of the electronics. These “indirect controllers” intend not to disturb any performance activity on the acoustic instrument

[137] E.g. The Hands by Michel Waisvisz 1984, 1989, 2005.

[138] Soundbeam (http://www.soundbeam.co.uk), Haken Continuum (http://www.hakenaudio.com/Continuum/), Nick Francis’ Choppertone (http://www.ableton.com/choppertone), Eigenharp by Eigenlabs (http://eigenlabs.com).

and also to allow the use of gestures akin to those used on the instrument (i.e. bowing gesture in the air rather on the string).

"Direct control" and "indirect control" is proposed as an useful differentiation of implemented controllers: "Direct controls" enable intensional changes of parameters for either operational or performative control gestures. The change of volume of the electronics with a fader is a prime example of direct control. The physical movement of the fader has an immediate effect on the parameter. Envelop following, using analysis to side-chain volume changes of a sound in dependence on the amplitude of another, is an example for indirect control. Here it is possible to generate data from performance gestures and apply these to other parameters.

When different audio sources (array of different microphones and pickups) are used with a number of effects, additional control demands arise to establish signal routing. This can be addressed by either hardwiring specific audio inputs to certain effects, or allowing a flexible system. The most flexible system obviously allows real-time changes to patch any of the microphones to any effect. Also, a dynamic routing system of the effects to the system output or to serve as the source for another process can be beneficial. These decisions on the signal routing and the serial or parallel use of effects determine the possibilities of the electronically enhanced system and indicate that the program design is a form of composition. Fixed signal routings will suffice for programs designed for a specific musical composition or a particular approach to a musical realisation, as it can be assumed that the design reflects the musical concern/ interest when it was written.[139] A concern maintaining instrumental potential for a wider context favours more flexibility, in its extreme, to allow any decision about the signal routing during performance. For example, changing the input for a ring-modulator from a pickup to an air mic shifts the focus of a very isolated sound source to open the possibility to consciously work with the room resonances and feedback. It also might affect the whole ensemble as the sounds of other players bleed into the microphone.

Similar flexibility might be desired for the control structure of parameters. Different musical scenarios might impose different requirements to control the system. Because discrete direct controls for every parameter might create cumbersome operation during

[139] A 'composition' which does not prescribe musical outcomes and realisations, but outlines the musical – and in within this context the instrumental – potential.

performance, grouping several parameters to a single controller can feel more natural. "Divergent mapping"[140] strategies also allow parameter changes to be designed in more complex ways. For example, while one parameter is controlled linearly, another might be changed anti-proportionally, exponentially or according to algorithms. It is aimed that the position of the controller sets specific constellations and mixes of the available processes and that the movement of the single controller allows quick and intuitive control of the processes. The very recent release of SugarBytes Turnado plugin[141] shows an interesting commercial application of this approach, exceeding the possibilities of the slightly more common preset morphing available in some commercial plugins[142]. The practicality of this method is undisputed, as it allows quick and complex changes with minimal operational tasks. However, implementations of divergent mapping reduce the flexibility of adjusting the system during performance. The distribution curves and parameters have to be designed prior to performance in relation to successful sonic outcomes. It can be a time consuming process and impractical to be changed on stage, unless the performer has the possibility to switch between presets of divergent distributions adequate for different musical situations.

"Convergent mapping" [143] strategies add the possible data distribution where one controller's range is dependent on another. I.e. the fader controlling ring-modulation would enact different values according to the position of a second. This is a particularly interesting scenario, as for example data streams of indirect controllers such as from sensors or audio analysis can have more or less impact on the process dependent on a single direct controller.[144]

The possibilities and complexities of the parameter routing are unlimited, but any design appears to have consequences for the performance. It can be assumed that every composer and performer has engaged with these issues in one form or another and solutions can be very individual. While some might prefer to work with fixed media

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[140] Hunt 2000.

[141] SugarBytes' Turnado (http://www.sugar-bytes.de/content/products/Turnado/index.php last visited 20.07.2012) appears to be the most sophisticated commercially available tools to date, allowing complex divergent effect mapping in the implemented Director.

[142] GRM tools (http://www.avid.com/US/products/GRM-Tools-Classic), Flux plugins (http://flux-home.com last visited 20.07.2012) .

[143] Hunt 2000.

[144] Using a fader to change the degree of ring-modulation invoked on the audio signal, i.e. fader value 0% would result in a fixed modulation frequency, 100% would open the amplitude reading to change the modulation frequency according to the loudness of the sound.

playback as the electronic parts would require sophisticated control structures they do not have available to them, others might design structures which enable a selected range of controllers or control data streams to control different parameters during the performance of compositions according to time-lines[145] or score following[146]. The idea to retain a more universal instrumental approach by designing a more flexible system which makes processes available for an augmented instrument is challenging. A possible approach is proposed below as the *piano+* incorporating a mixture of these approaches and is described in more detail in Chapter 4.

2.5.3. Audio Analysis

Indirect controllers are considered more suitable for augmented instruments as they allow the user to extract control data from performance activities themselves. Audio analysis is an obvious candidate for this and resembles a means to design a program listening to what is happening in the sonic realm. Trackable audio features include readings of amplitude, onset and various frequency analysis methods, which are mainly based on the FFT[147]. It has to be taken into account that human listening is not restricted to the perception of acoustic properties of sound, but involves a complex cognitive evaluation and interpretation of the sounds. Although much research is devoted to improving audio analysis tools[148], especially with regards to implementing sophisticated algorithms. Implemented algorithms attempt to interpret the information as unprocessed data always appears to be 'hyperactive' – they work constantly even when a human would not consider it to be a relevant or significant musical event. The implementation of thresholds for the algorithm remains only a (often appropriate) technical workaround for specific situations. Differences in the music might require adapted settings. Audio analysis cannot provide aesthetic evaluation between musical, accidental, or environmental sounds. The complexities of human listening processes can only be approximated and modelled by algorithms or rules in an attempt to relate the data to the musical performance. The combination of different audio analysis tools as convergent controllers can offer some better data interpretation. For example, the reading of

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145 Javier Garavaglia, *Ninth* (2002).
146 Pierre Boulez, *Anthem* (1994).
147 Fast Fourier Transform (Roads 1996, 494-609).
148 The open source code for fiddle~ has been adopted for the analyzer~ and pitch~ objects, a sophisticated library of tools are available as the zsa.descriptors (Malt/Jourdan 2008).

dominant partials in the frequency spectrum combined with a general amplitude reading can help to distinguish between musically relevant readings during the production of a sound and values received in moments during which perceived ‘silence’ is analysed. A consistent design of the system in terms of instrument, microphones, and their placement can be advantageous, as many of such convergent controllers require careful testing and calibration.

The use of audio analysis data streams to implement indirect control structures enables the linking of the acoustic performance with electroacoustic modification, which can give very satisfying results, especially in carefully planned studio sessions. This can turn easily into frustration in live situations, or other less controllable environments, when time constraints, stage settings and audience noises might compromise possible results. The experimental approach to improvised performances has enabled an attempt to get good readings from the audio sources, but equally avoid to become preoccupied with improving the algorithms and the results. It will be discussed in Chapter 5 how imperfections can be considered and exploited as contingent behaviour with interesting and highly musical results.

2.5.4. Algorithmic and Intelligent Instruments

‘Machine listening’ implemented by means of audio analysis finds an interesting partner in algorithmic composition: both appear to merge as a virtual musician. However, the algorithms appear also in separate software. Chadabe claims that the processes of M[149], “partly based on random number generation, simulate the complexity of improvisation. To whatever extent you direct it to do so, and in whatever way you direct it, M improvises on your musical material.”[150] The role of randomness is essentially a means to implement “elusive causes” which can inspire and give unexpected and new direction to the musical outcomes. “It might be a bit unusual to associate randomness and intuition, but they are both the results of underlying and elusive causes.”[151] The translation of the randomness into rule based processes has attracted considerable research for possibilities to merge musical expectation with an element of freshness and

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[149] First published by Intelligent Music in 1987, no available from Cycling 74. http:// cycling74.com/ products/m/ last visited 20.07.2012.

[150] Chadabe 1991, 143.

[151] Chadabe 1991, 143.

surprise. Each project differs in approach and intend but nevertheless there is an element to establish an autonomy of the system, which eventually results in a virtual musician. Biles' *Gen Jam*[152] and Lewis' *Voyager*[153], both generative algorithms capable to accompany a live musician, have a very different result. While Biles created a very sophisticated accompanying partner trained in a selection of music genres, *Voyager* is embodying an encoded version of Lewis' understanding of jazz and improvisation. Both algorithmic systems calculate performance data about pitch, rhythm and dynamics, which are then rendered by MIDI capable instruments or synthesisers. This is of significance as in this way the algorithm deal with the material as if generating a real-time score. Edwards also points out his generative composition software *slippery chicken*[154] to have reached "the stage where it can generate, in a single pass, complete musical scores for traditional instruments or with the same data write sound files using samples or MIDI file realizations of the instrumental score"[155].

Continuing advances in algorithmic and generative software technology shows that possible solutions can include audio analysis to create sophisticated sound dependent relationships between live instruments and sampled audio in real-time[156]. Diemo Schwarz's *CataRT*[157], Michael Casey's *Soundspotter*[158], and David Casal's combination of Casey's MPEG-7 technology and co-evolutionary algorithms in *Frank*[159] are impressive examples of synthesising the electroacoustic accompaniment for an acoustic instrument from fragments prerecorded and analysed audio files. A real-time analysis of an audio stream can be utilised to establish close associations between live and the retrieval of sampled material, i.e. in form of material with the closest match of descriptors stored in the database. It has been an interesting experience to hear Casal's piano performance[160], where music by Anthony Braxton, Cecil Taylor and Ligeti

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152 Biles 1994.
153 Lewis 2000.
154 Edwards 2000.
155 Edwards 2012, 64.
156 An overview of the research involving Music Information Retrieval is comprehensively given by Downie (2008). The proceedings of the dedicated conference International Society for Music Information Retrieval (ISMIR) indicate in particular the scale and variety of work in this field. While its techniques and outcomes yield much relevance and interest to this thesis in general terms, the research and implementations of these methods within the available performance opportunities and venues proved impractical.
157 Schwarz 2006.
158 Casey 2002.
159 Casal 2007.
160 Interlace performance 01.04.2006. Archived recording available on http://inter-lace.net .

became the orchestral accompaniment to the solo piano. The analysis of the musical gestures of the solo piano was used to retrieve short fragments out of the database compiled of these recordings. It is an example of consequent computer control derived from the music itself: the computer playback follows the piano performance step by step, so that a peculiar parity in musical structure emerges between the instrumental and electronic part. Casal's performance remains locked within a continuous stream of musical references and 'anecdotes' in forms of fleeting impressions from the material stored in its database. It moves within an aesthetic of de- and reconstruction: it plays with memory and time perception, reminiscent of Oswald's Plunderphonics, despite its real-time properties. Casal's work is considered very significant as he has achieved a direct link to the electronic part of the performance without relying on direct control methods and in absence of implemented fundamental musical rules. Whereas Lewis' *Voyager* is based on meticulous implementation of harmonic, rhythmic and motific possibilities, *Frank* works with real-time audio analysis and pre-analysed audio recordings. Therefore the 'musical language' is not determined by the musical rules, but by the audio resources used. Casal's system reacts entirely differently when loaded with different recordings despite employing the same algorithmic links. The associations of the timbre between the performance and electronic response will be perceived differently. For example, trills would not be accompanied by dense textures of the Ligeti if the database does not contain material which features fast changes in pitches. Strong links are created between piano and electronics at the micro-structural level: musical gestures and motifs create clearly perceivable causalities which is suggestive of a musical dialogue between the piano and accompaniment.

2.6. Concerns About the Electronic Instrumental Space

The need for the implementation of rules to create complex instrumental tools suitable for one's musical concern highlights the intrinsic relationship between the practice and its tools. The definitions, meaning and structural concerns are reflected within the structure and features of the software[161]. This is apparent in commercial software, where the workflow might suit particular ways of thinking, but might disallow other

[161] Ludwig Wittgenstein comes to mind in this context: Within any attempt to conceptualise and design a computer program interesting similarities to syntax and grammar of language emerge.

approaches. Tools such as Max/MSP, Supercollider, Processing etc. have opened in many respects the computer for more individual tools to be created, but in reverse requires the musician to engage in computer programming. In some respects this does not differ significantly from the need of a musician to engage with the acoustic instrument beyond the technical modes of sound production. Learning an instrument involves engaging with its material and principles. Some instruments might require a deeper understanding from the very beginning than others: a violinist gains intuitive knowledge about the physics of strings from the very first encounter, while a pianist might spend years in ignorance what the instrument consists of.

The instrumental paradigm is not applicable to the computer *per se*. The computer is an 'empty box' required to be filled with processes to gain instrumental properties. The techniques implemented in the software are a result of concerns and ideas about the music around us. Our interests, which in themselves are rule-based, correspond to our beliefs, knowledge and aesthetic. The design of a performance system ought to outline a space of potential which facilitates explorations similar to their acoustic counterparts. Within any process, defined by the combination of electroacoustic effect, control structure and signal routing, new and unforeseen results can emerge. When the process and its underlying rules are consciously detached from actual musical content during the design stages, potential meanings can be explored thereafter. More importantly is that the (by necessity) implemented rules within the process are consolidated and understood. Most strikingly is here the metaphor of the ever-changing layout and infrastructure of a City, as e.g. used by Wittgenstein:

> "The techniques that constitute a language take their point from what lies around them, in the eyes of those who use the language, rather than from an abstract and idealized conception of what representation *must* consist in. New techniques arise and others fall away, not in response to any constraint imposed by the essence of language, but in response to the needs and purposes of those who employ them. Wittgenstein captures this idea of language as a shifting motley of techniques by comparing it with a city (*PI 18*), in which ancient streets are constantly added to and what is there is subject to continual modification; the idea of completeness simply doesn't apply."[162]

A fascinating dilemma emerges here. On one side a certain fixture is required to allow a performer to develop an intimate and immediate relationship with the instrument (composed instrument) in order to become 'at one' with the instrument by learning the instrument in the way we are able to learn an acoustic instrument. On the other hand,

[162] McGinn 1997, 50.

changes of the performance setup become (or at least feel) necessary to optimise the musical potential. In many cases the required changes in the program structure and parameter ranges need an interruption of any performance activity. Even small alterations of possible parameter changes can turn into an activity which requires to be dealt with separately in dedicated hours of development and preparations.

There appears to be a fine – and difficult – line between artistic reasons of refraining from redesigning the piano, but to feel the need to redesign software to suit an envisaged purpose. The main reason for this lies in the physical properties of material used for acoustic instruments and the ‘empty shell’ which requires software. A continuous investigation of a musical activity using physical objects can stretch the physicality of the used material, i.e. material being stretched beyond initially intended forces, but also loosened beyond intended tensions (both cases relating to strings). At a certain point, a shift of paradigms may occur. A string too loose to produce an audible pitch might hit surrounding material, such as the fingerboard, casing, etc. continuing to produce musically exploitable sounds. In cases of breaking, i.e. a string breaking under the applied over-stretching, the instrument (including the pieces of the string) is still 'available' and 'useable', arguably not in its intended form. Electronic devices do not allow such multi-facetted paradigm shifts. Within the process of designing the software, decisions about parameter range and its interdependencies were put into place. Only what is made available to change can be changed within the defined ranges, and adjustments to minimum and maximum values are only adjustable if this was implemented. If within a performance activity (i.e. using a fader) a certain parameter has been set to its maximum, no physical force applied to the fader would allow a further increase of the values for any foreseen or unforeseen effect. The implemented range would need to be adjusted, possibly using another parameter, or worse, by having to make adjustments within the software. The point of actually breaking the fader, would not result in a paradigm shift, the process would continue unchanged, yet the means of interaction would be missing. In case of actually 'breaking the process', i.e. crashing the software, all means of sound manipulation would vanish. The only 'thing' left is the casing of the computer, which in itself serves as a very limited sound source.

Chapter 3: Free Improvisation

The more general considerations about live electronics, which over the first two chapters established a historical perspective and outlined its impact on performance conventions by looking at the significance of the instrumental paradigm. The concept of an instrumental space proposed in Chapter 2 establishes a unity between performer and instrument that goes beyond mere technical proficiency and helps to focus on the activity of improvisation. The initial motivation for this thesis originated from my attempt to find practical ways to include electroacoustic sounds within improvised music. It is therefore necessary to discuss free improvisation in relation to more recent strains of philosophical and psychological research before exploring instrumental design, computer programming and interactive strategies further. This research aims to develop a theory that convincingly unifies performer, instrument and performance situation, for which technology and the understanding of a particular approach to improvised music ultimately plays an integral part.

By discussing some intrinsic characteristics of improvisation a definition of improvisation as an activity is established to differentiate between free improvisation and techniques of improvisation found in other musical genres. Bailey distinguished between idiomatic and non-idiomatic improvisation[163] The dichotomy between known idioms of a defined stylistic genre and a more independent and individual musical voice will serve as a starting point for this discussion. Selected models describing cognitive processes of improvisation[164] will be evaluated by drawing direct reference to Agamben's philosophy of potentialities[165]. Further developments of the discourse will involve Kuhl's psychological PSI-theory[166] to show that non-linearity in thought is fundamental to human behaviour because perception, memory, intentions and behaviour are regulated in a complex network by the way the person feels. A form of improvisation is described which goes beyond the security of pre-learned techniques and material and utilises knowledge and experience exceeding the musical. The

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[163] Bailey 1993, first edition 1980.
[164] Pressing, in Sloboda 1988; Sarath 1996.
[165] Agamben 1999.
[166] Kuhl 2001.

acceptance of contingencies and potentialities becomes an essential element in musical performance within free improvisation.

The term improvisation has inherent complexities that focus on the moment, the notion of temporariness and activity. Any attempt to define improvisation in universal terms seems inappropriate, as each definition adds yet another view to the already diffuse and diverse understandings and definitions. The fundamental nature of improvisation escapes concrete definition because it differs significantly within stylistic and cultural contexts[167]. Any definition that refers to underlying rules and guidelines introduces a contradiction between fundamental claims and rules. Investigation of an improvisatory approach within a single cultural and stylistic environment reveals definable musical elements and parameters, which tend to remain unformalised but nevertheless indicate and outline detailed and complex general framework. Such genre specific improvisation is defined by Bailey as "idiomatic"[168] improvisation. Sawyer, despite not using the term explicitly, indicates a similar thought when he describes "musical communication [...] depend[ing] on all of the musicians knowing the 'language' extremely well"[169] which is part of a "code of conduct" and "convention"[170]. Improvisations outside such frameworks would by Bailey be termed "non-idiomatic" improvisation. These two terms have to be considered useful only within limits, in particular the term non-idiomatic yields some fundamental problems which will be discussed below in Section 3.5. These terms ought to be seen as a description of different approaches, rather than a means to describe and categorise the diversity and identity of musical outcomes.

Dell's *Prinzip Improvisation*[171] shows how a theoretical and empirical discourse which includes and relates improvisation beyond the musical to more general aspects in life. The term 'free improvisation' is associated with a form of improvisation which is described by practitioners like Derek Bailey[172], Eddie Prévost[173] or Cornelius Cardew[174]

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[167] Bailey 1993, 1-58, as well as Bailey's 4-part documentary "On the Edge" broadcasted on Channel 4 in 1992.
[168] Bailey 1993.
[169] Sawyer 2003, 32.
[170] Sawyer 2003, 50-52.
[171] Dell 2002.
[172] Bailey 1993.
[173] Prévost 1995.
[174] Cardew, 2006. Article on the Aesthetics of Improvisation first published in the Treatise Handbook 1971.

and John Stevens[175] in diverse first hand accounts. John Zorn[176] initiated a collection of writings by musicians and artists working in experimental music, showing the diversity and multitude of contemporary performance practices. An overlap of underlying strategies and directions emerges even in these mainly brief artist statements. Within secondary literature, Klopstock[177] has compiled an overview of practices and approaches by musicians, groups and ensembles working within free jazz and free improvisation. The majority of writings indicate, sometimes explicitly, but often only implicitly, that improvisation is concerned with an activity, an action.

The plurality of approaches and concerns is striking – although not surprising – as improvisatory practice is essentially a deeply personal affair. An underlying concern of freedom is nevertheless prevalent: freedom and room for personal expression, freedom from stylistic constraints; a voice for independence, equality and emancipation; the collective – the "intersubjective"[178], as opposed to the objective and subjective.[179]

3.1. Improvisation as an Activity

The description of improvisation as an activity, which draws from various considerations and not exclusively from music theory, appears to be the most fruitful. Dell uses the word 'principle' and stresses an individual creativity reaching outside the private sphere. An "attitude", "approach", and "engagement"[180] is arguably a valuable and accurate description considering the varied areas in which one can find references to 'improvising'. And, of course, there are non-musical improvisational processes found in the activities in everyday life.

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175 Matthew Sansom also associated the term 'free-improvisation' with the Spontaneous Music Ensemble (John Stevens), Derek Bailey, AMM (incl. Eddie Prévost), and C. Cardew (Sansom 2001).

176 Zorn 2000, 2007, 2008.

177 Klopstock 2002.

178 Sawyer 2003, 8-9.

179 Although it would appear beneficial to associate specific concerns with specific musicians, I would consider such an attempt only futile and wrong, as their individual struggles, expressions and achievements cannot be put in any hierarchical order, i.e. the racial struggles of musicians such as Anthony Braxton, George Lewis, Leo Smith etc. who joined the AACM are fundamentally different from the work of their European colleagues.

180 Dell 2002, 17: "Improvisation ist dem Ausdruck, der Suche nach einer individuellen Kreativität verplichtet. Ihre Sphäre reicht trotzdem über das rein Private hinaus, [...]
Denn Improvisation ist vor allem eines: attitude, Haltung, Einstellung zum Miteinander."

A general recognition and acceptance of improvisation in every-day situations exists. Improvised activity is required to find adequate and suitable solutions to unexpected and immediate problems. Such situations often have a negative effect upon those involved, as there is an urgency (Dringlichkeit) to be dealt with. For example, when an immediate solution is needed but particular tools and materials are not available[181], an improvised response is required[182].

Within speech, improvisational tactics can appear in conversation, where the intended meaning is paraphrased by analogies and metaphors, or even physical gestures. This might be especially so if the speakers do not share the same language.

It is also perhaps part of human behaviour to test existing rules and customs, as for example children try how far they can go before they face consequences of their actions. A high level of creativity is often required when negotiating such situations. Even when the improvisatory element is restricted to finding suitable material and techniques for repairing objects, a creative approach is apparent that cannot be denied. There can, however, be great disparities in sophistication and rigour of any experimentation. Improvisatory experimentation can become the interest of action in itself and disconnect itself from an immediate necessity. Furthermore, activities can range from the purely practical to more intellectually driven games and hypotheses. The following characteristics outline this range and are meant to be seen in relation to an underlying intensification of acumen, astuteness, cleverness, ingenuity, alertness, attention, feeling for opportunity, expertise and experience in the human behaviour[183].

1. Problem:

Perceiving a problem preempts improvised activity. This might cause an urgency that requires immediate action, perhaps pushing the person to their limits. Problem constitutes an impulse for change, even if not necessarily an urgency.

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[181] To fix a leaking pipe with adhesive tape, or by using tools which were not designed for such purpose; or the use of nylon stockings to repair the fan belt in a car.

[182] There are of course other situations which can lead to improvisatory activity: enabling the development of suitable substitutes of materials, tools and objects which are too expensive, or locally unavailable due to other circumstances. Also political circumstances where people are forced to work outside legality to pursue their aims.

[183] Dell 2002, 71.

2. Response:

An improvised activity is a response to an impulse. The ability to improvise with limited materials and tools has the quality of “on the spot” and immediate invention. The time factor plays an important role, as more considerate and planned solutions might be too late.[184]

3. Spontaneity:

Improvised activities occur spontaneously, they might even be considered as intuitive responses. This also includes the ability to act in the moment.

4. Adaptiveness:

A continuous direct relation to context and environment is required as the stimulus for an immediate improvised response. This indicates the need to be continuously aware of any changes in the current situation and able to adapt at any moment in time.

5. Game and play (ludo):

The playful handling of rules and guidelines in connection with games has a close relationship to exploration. Play as a means to rehearse to acquire skills, strength and agility required to cope with the challenges in life. The word root of ludo, ‘I play’, appears in ludic and ludicrous. While the first describes a spontaneous and undirected playfulness, the other carries a clear negative connotations. The play which has gone too far. However, the game at its most successful is when there is room to adapt the rules. This allows for degrees of ability, situation and environment to play out. It also prioritises dialogue; enhancing potential sociability[185].

6. Intention:

Improvisations require intentions that arise within the dynamic of problem-solving (see 1.). Intuitive responses can play a part in improvisation, but it is not the essence of it. Intuitive behaviour is limited to unconscious processes that

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[184] Helping in the events of accidents or situations of immediate need are the most striking moments in which the improvised activity is often most highly regarded.

[185] A further possible development of the thoughts about the ludicrous: the ludicrous is considered the foolish, the unreasonable, and what has exceeded the amusing. Does this indicate why many people depreciate improvisation?

enable fast and immediate responses (reflexes) in particular situations of danger (i.e. running away, hiding, etc). Improvisation requires intentional thoughts, consideration and conscious and deliberate activity.

7. Duration:

Improvisation is temporary, it has no duration beyond the time of the activity itself. The improvised activity is bound to a particular occasion: its solutions are not intended to last. Therefore ideas which solve the problem within an urgent situation have immediacy, without necessarily claiming to be the most appropriate possibility available.

It is also important to consider that the context and conditions of one's activity can change very rapidly. Therefore the response to a particular stimulus might quickly become irrelevant as the causal relationship require new responses.

8. Endeavour:

The motivation to achieve something is important in improvisation. Change also gains significance through intention. This forms a link between activity concerned about necessities and the more abstract activity attempting to improve the current situation or state.

9. Development:

Very closely related to the points raised in point 4, aspects of development and progress on a personal as well as social level are apparent. In its simplest form development occurs because every improvised solution constitutes a gain in experience, positive or negative. However it is an "affirmative interaction and creative use of the provisionals as an attempt to reconstruct practical reasoning"[186], a "bodily and autobiographical knowledge of the self"[187].

10. Hypothesis:

Problems can be a construct of an intellectual kind. Even difficulty of execution can generate a continuing interest in the activity. Problem-solving can become an intellectual discipline in its own right. This requires a deliberate act of recognising a problem and therefore differs from an intention to find momentary

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[186] Dell 2002, 69.
[187] Dell 2002, 72.

solutions. The existence of the idea that multiple solutions can be found and developed can become the main interest of the activity itself. Such activity is probably closest to the conventional definition of composition. However, the characteristics of spontaneity and temporality, of course, operate within the domain of the moment: the real-time[188].

11. Heuristic:

The holistic qualities of improvised activities are the immediate result of the knowledge accumulated through the processes involved. Kairos describes the moments when the maximum of accumulated knowledge is condensed to the minimum of time to find appropriate solutions within the current moment and context. Any result expands the experience and knowledge. This expansion is a recursive process which can have a direct impact – or at least possibility – to influence further outcomes. This forms therefore “practical knowledge” which describes “a ‘bodily’, autobiographical knowledge acquired [through] improvisation”[189].

12. Social:

Improvisation happens within a social interaction. One must be aware and alert for the spontaneous changes in direction and approaches. There has to be a willingness to respond to new stimuli and incorporate their characteristics through compromises and adjustments. Above all this recognises the potential arising from a continuous fruitful dialogue, during which a person becomes nurtured and scrutinised within every moment. “To actualise and to align [oneself] to others [... to the extent] that often the initial impulse [for the activity] cannot be retraced, i.e. it looses its relevance. [...] What remains important is that this happens within the shared discourse of those being together”[190] This also highlights the importance of ensuring personal responsibility for one’s own actions within the collective creative situation. The overall collective potential

[188] It is very interesting at this stage to note that for example Jonathan Impett refers often to the term “real-time composition” for his performances involving computerised control strategies. In a similar vain Rowe 1999 and Risset 1999 relate the term “real-time composition” to work with electronics.

[189] Dell 2002, 72.

[190] Dell 2002, 110: “Aktualisieren und Ausrichten an Anderen ... in denen der eigentliche Impuls [der Handlung] oft nicht mehr zurückverfolgt werden kann, das heißt keine Rolle mehr spielt. ... Wichtig bleibt dass dies im diskursiven Raum des Miteinanders geschieht”. Translation by Elke Schwarz.

becomes otherwise tainted by the domination of a singular or even egocentric approach: irrelevant and trivial statements deliver little for collective progress.

To summarise: most of the above descriptions involve a situation in which the person encounters a negative sentiment, a dissatisfaction, or even a state of emergency. The positive emotion that will arise after successfully improvising a solution can easily enhance a person's self-esteem. However, the fact that the problem had been solved in an ad hoc situation retains a sentiment that is only a temporary achievement. There is an assumption that 'one only improvises' in moments when nothing else is possible – that improvisation only occurs out of desperation; *any* solution would feel like a great achievement. There is also a sense that given more time, consideration and thought such provisional solutions would be exchanged with more carefully planned, carefully considered, and accurately executed solutions. These would have been proved over time, or at least have been developed over a longer stretch of time and are therefore considered as more valuable and sustainable. Therefore, one could argue that for any improvised solution something even more appropriate and suitable should be developed over time. As a consequence improvisation has been seen as a suitable approach for scouting out new skills, which eventually find full potential in value within a more considered and conceptualised context. Is improvisation the playground for compositional techniques?[191] Or, should we consider improvisation to have potential as a unique — if troublesome — independent musical idiom?[192]

3.2. The Negative Sentiment

Successful improvised activity could be defined as the unlocking of possibilities within a given situation, rather than finding adequate preexisting selections. There is an assumption that initial intuition and boldness in decision-making is required. Inhibition,

[191] Stockhausen's experimented on a tam-tam installed in his garden. He describes a selection process for the sounds used in his composition Mikrophonie I, which implies that Stockhausen is only interested in the arrangement of the sounds in the structure he composed rather than in the method of developing and producing the sounds. (Maconie 1989, 78)

[192] This view had been forcefully put forward by a composer in a discussion forum at the Biannual Music Conference on Twentieth-Century Music housed at Goldsmiths College in 2001 (an inadequate note about the discussion appeared in Tempo No. 218 (2001): 39). A similar reaction was experienced in a postgraduate symposium on notation and improvisation in 2002. In a discussion about improvisation at the Drawing Room, Hackney, in Nov 2009, a composer could not accept the possibility of any meaningful musical structure to emerge in absence of predetermined arrangements and concepts.

uncertainty, and fear could impede spontaneity, limiting the openness and willingness to adapt one's activity. Constant awareness, alertness, and a continuous evaluation of processes seem necessary to enable further (re-)actions which reflect further unforeseen or previously underestimated circumstances. In certain extreme situations, individual survival might depend on the outcome, but nonetheless any situation experienced will result with a feeling of achievement or failure.

Improvisation in everyday life requires sensitive and accurate perception and imagination, not dissimilar to the artistic processes where new meanings and references are explored and developed and new possibilities of activities and materials are rigorously tested. This activity relates to the conscious or subconscious application of accumulated knowledge and experience required to solve problems which are frequently too complex for a rational analysis within the moment.

Does the improviser need to perceive a problem in order to improvise within a new musical terrain, that is, to go beyond the structural arrangement of previously accumulated and learnt musical events? And, does this requirement extend to the audience and become necessary for any critical discourse? Do we require at least a subtle objection to, if not even dissatisfaction with, performance routines? Is it possible to reduce the dialectic to the mix between the familiar and the fascination to explore the unknown?

The interaction between positive and negative emotional responses might ultimately be responsible for the activity of improvisation. This could also serve as an indicator: why improvisers appear to get more out of the musical engagement than those purely witnessing the proceedings[193]. Although there is the danger of simplistic generalisation, this serves as an important element in the attempt to discuss the possible evaluation of improvisations. It indicates the need to consider the activity of performance above the actual audible result.

Bailey proposes that the first musical activity must have been improvisational[194]. This fairly unsurprising statement also emerges in the discourse by Edward O. Wilson[195],

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[193] It appears striking that many of the audiences of improvised music are active musicians themselves.
[194] Bailey 1993.
[195] Wilson 2009, 250.

who attributes the adaptive qualities of artistic activity – on the evidence of artistic and musical activity in the stone-age – as the accelerator for the development of the human species. Both indicate a much more complex relation between the improvised approach in human development without questioning the significance of fixed methods and value systems in the establishment of unifying, resilient and secure environments, culture and tradition.

3.3. Idiomatic – Interpretation – Authorship

An evaluative system of improvisation should focus on the continuous departure of predefined structure and methods. A brief look at conventional performance is needed to clarify Bailey's term of idiomatic improvisation. The existence of idioms in improvisation assumes at least loosely determined approaches to harmonic, rhythmic and timbral elements of the music. Components which can be learnt and internalised to such a degree that performances might be hardly more than a pastiche of their roots, for example by utilising precisely defined harmonic structure and scales. A jazz performance of such a kind, claiming to be improvised, could hardly be considered as anything but shallow[196]. It bears, however, similarities with the interpretative approach in the performance of classical music.

Classical performance requires the musician to transcend the technical requirements of rendering the work: it "demand[s] a solution for most of the technical problems of making music *before* the music can be performed"[197]. This process requires the establishment of the relationships between the notes in the vertical (harmonic) and horizontal (motific and melodic) arrangement by skilfully adjust timbre, dynamics and tempi, in order to create the representation of the work[198]. The linear sequence of instructions – the score – is used to prescribe the composer's view of how the relationship between musical elements, compositional processes, intentional meaning and structural design become perceivable within a cohesive form. Jazz performances might move beyond the established harmonic, rhythmic and melodic material, because

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[196] An approach to jazz which seems to be considered as appropriate for teaching, in particular as it enables a convenient way to develop evaluating and grading systems.
[197] Prévost in Cardew 2006, 295.
[198] This approach shows similarities to the term misesis as described in Dell 2002.

the alterations applied by the performers stretch the music beyond the obvious forms of musical variation. The placement of the musical references in the overall structure (the way audiences are led through the development of musical material) is also significant for the possible perception of the musical discourse. Many jazz genres leaves more fundamental decisions on rhythm, pitch and harmony to the performer, in addition to the elements mentioned with regards to classical interpretation. This introduces a degree of nonlinearity to the musical activity: because musical references can be made purely from memory. They neither rely on any chronology in time nor in the order of motifs, harmonies or rhythms that appeared in the original. Nor do they rely on the order these were learned[199]. References to existing material are part of the jazz aesthetic and are a point of departure as well as appreciation through repetition. Performers are taking on an increasing amount of authorship and responsibility for the presentation of the music. They increase their authorship as they enter the realm of creation[200]. The increase of authorship within this context does not imply to aim for a commodification by expanding capitalistic revenues of the musical results (by bypassing the traditional function of the composer[201]). It is to engage in a continuously enquiring freedom, to "materialize fluidity and futurity within practices of performance [... as] an exploratory, nomadic principle that asserts itself and shapes its contours [... by] stepping into nonpositionality"[202] within the cultural and traditional. The more such shifts have occurred or 'infiltrated'[203] jazz performance, the closer we get to free jazz. The interest also shifts increasingly towards an appreciation of how the music has been constructed from idiomatic stylistic and motific components within the moment of its performance, rather than how a preconceived work was rendered. The balance between anchor points to familiar components and intentional departures from the expected, tilts towards the unknown. But within the perception of musical structures a "paradox lies in the tension

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199 Weick proposes the terminology of "retrospective form" in jazz "not just because of its temporal quality of looking back, but also because it suggests the quality of bricolage, and the activity of a bricoleur." (Kamoche 2002, 173) and uses the definition of bricoleur by Thayer: "a person who makes things work by ingeniously using whatever is at hand, being unconcerned about the "proper" tools or resources." (Thayer 1988, 239) which links nicely back to the initial qualities listed for improvisation (Chapter 3, 7-9).

200 Dell 2002: poiesis.

201 This transferal of functions from the Composer to the Performer has been vehemently criticised by Xenakis (Xenakis 1992, 38) as an insufficient compositional process, arguing that leaving essential parameters in the music to the performer will in consequence have their conditioned background leaking into the performance of the composition.

202 Bell 2003, 25.

203 'Infiltrated' has been chosen here to anticipate the quote by Albert Murray below (footnote 205).

between the imperative to repeat antecedent structures and the necessity to do so in a way that expresses originality”[204], to find public appreciation for the activity. Such views and sentiments are common, and dismissals of freer forms of music making might best be represented by a statement of the jazz critic “Albert Murray [who] angrily exclaims against free jazz that ‘art is supposed to be a bulwark against chaos.’”[205]

Cornelius Cardew discussed the “felt structure”, the interpretative directions generating the “need” or “wish” to deviate from the directive given in the score[206]. Physical processes and methods of execution are based on rules and directives formulated to govern the performer’s activity. Rules are either supplied as notation, descriptions or other idiomatic elements informed by culture, tradition, aesthetics and morality. A Modernist characteristic is to scrutinise the existence of rules and traditions, or even to ignore these altogether. A possible strategy could be to engage in an activity within an unfamiliar medium, to ensure a fresh approach freed from established techniques, methods and thoughts. Cardew looked for the musical innocent for the interpretation and realisation of *Treatise* (1963 - 67). It was not a question of replacing the conservatoire-trained musician but looking for an interpreter who could draw from a far richer bank of knowledge and experience and for whom “moral discipline is an essential part of the training”[207]. He hoped for a wide range of perspectives, utilising personal experience acquired in several different disciplines, to develop an interpretation of the graphic score in a beneficially free and fresh manner.

3.4. The Absolute Versus the Event

A representative character of classical performance is prevalent from its predominant concern to strive for the absolute and ultimate where interpretation meets the intentions of the composer.[208]

> “Representation leads to exchange and harmony. [...] Even though representation may lead to the enactment of a conflictual classification of social realities [...], their representation in the theatre of politics inevitably leads to the organisation of

[204] Bell 2003, 22.
[205] Bell 2003, 24.
[206] Cardew 2006, 130.
[207] Cardew 2006, 126.
[208] Representative to be understood in Attali’s definition of “Representation”: Attali 1986.

> harmonious exchange, fixed borders, compromise, and equilibrium. No system of representation can find a lasting foundation in the absence of harmony."[209]

The harmony described resembles the objective values referred to when the masterworks of artists are discussed. The skill in creating artworks which can speak to everyone and which have timeless relevance is considered as an absolute achievement.

The idea of the "absolute", as described by Hegel, continues to govern and influence musical performance, despite the challenges to the fundamental definition of music and its structures during the last century. When considering freer forms of improvisation, Giorgio Agamben's discussion of potentiality provides an alternative to the idea of perfectly rendered and executed performance. The "absolute" is a firm reference to the past[210] ("like never before") and simultaneously implies a claim for future validity ("like never again")[211]. "Hegel's determination of the Absolute is characterized by its appearance as "result", as being "only at the end what it truly is".[212] According to Agamben, Hegel's concept of the Absolute has absolved itself from the subjective individual as something which was "conceive[d] of what has *become equal to itself in its being other.*" This "corresponds to [an] attempt to absolve the subject [the performer] of [their] necessary relation to the event"[213]. In the development of the argument, he draws on Heidegger's focus on the "event" (*Ereignis*) as it relates to "the verb *eignen*, "to appropriate," and the adjective *eigen*, "proper" or "own""[214]. The event in consequence diminishes reference outside the present as it has a "finitude in itself"[215].

To strive for the "absolute" is a goal for many performers and audiences, in particular within classical music genres. This goal is also found in jazz, although the idea to achieve the absolute has to be scrutinised fundamentally for music which is created in the moment utilising creative decisions that go beyond the concept of interpretation. Each performance is unique and has a distinctive quality. Therefore the 'event' has to be appreciated more than any compositional framework on which it was based. The term

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[209] Attali 1986, 62.

[210] Audio technology helped to push performance to its extremes, facilitating the generation (rather than the preservation) of performances for a posterity in which virtuosic and technical precision and interpretative finesse excel.

[211] I have used a slightly paraphrased version of Benjamin's "never seen before" and "what was never written" which appears in the editor's introduction to Agamben's Potentiality.

[212] Agamben 1999, 121.

[213] Agamben 1999, 121.

[214] Agamben 1999, 117.

[215] Agamben 1999, 129.

Ereignis (event) omits the claim for eternity, the very claim embedded within the definition of the 'absolute'. The recognition that the 'event' is limited in time allows or even advocates the appreciation of an activity for what it is within the moment, "to grasp the very movement of pure temporality and pure Being, beyond what is temporalized and said in actual discourse"[216]. Although it is possible to appreciate an 'event' as the 'absolute', such a claim for eternal validity becomes absurd, as it makes future events pointless and also negates further progress and change.

A further significant aspect emerges here: The stimulation of an interest in progress over time beyond that of one performance. How did the performance develop from one event to the next? How did the act of creation alter from the previous? One starts to develop an interest in the underlying process revealed through continuous change. The focus shifts from concerns about the actual musical results (end gaining) onto the processes involved in its creation. The progress emerges through differences and changes and shows significant similarities to a reflexive form: Any personal skills, knowledge and experience forming the basis of the improvised activity will have been transformed in the course of the activity. The performance is therefore a "reflexive" journey of the self: "a departure from the self and a return to the self"[217]. Such an event is placed firmly into the present that "refers to a history of the individual while simultaneously a new beginning is being set."[218]

3.5. Critique of the Non-Idiomatic

Bailey describes improvising without predefined underlying musical components. He suggests the possibility of a practice to go anywhere without constraints, especially those imposed by association to specific genre and culture as "it has no prescribed idiomatic sound"[219]. Although this term indicates a clear distinction from the idiomatic, it leaves a bitter taste of ambiguity when one considers its counterclaim: improvisations associated with a non-idiomatic approach share an intention to avoid recognisable reference to existing genres. Why would the individuality of an improviser's work be

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[216] Agamben 1999, 121.
[217] Agamben 1999, 116.
[218] Dell 2002, 41: "Jede Improvisation verweist auch auf die Geschichte des Individuums und setzt zugleich einen neuen Anfang". Translation by Elke Schwarz.
[219] Bailey 1993, 83.

considered of less value if references to an existing genre are recognisable[220]? The scrutiny of the non-idiomatic gathers even more weight when considering that established free improvising musicians can often be recognised and identified after a very brief time of listening: individual playing style, musical material, tone production and instrumental techniques show striking characteristics. Therefore "a distinct and familiar voice that emerges from any practice of free improvisation [...] also suggests that a certain amount of consolidation of a personal idiom has occurred"[221]. Bailey acknowledges that "the characteristics of freely improvised music are established only by the sonic musical identity of the person or persons playing it"[222]. Therefore the non-idiomatic relies on the individual, the subjective, and the personal, which might appear detached from traditions and culture. However, while the activity occurs, it becomes part of cultural activity, and therefore becomes a potential source of further uses and developments. For example, the saxophone style by Evan Parker and John Butcher are detectable in the playing of many contemporary improvisers. And, speaking personally, I would not deny the inspiration of inside piano techniques, which have appeared within the piano repertoire during the last century through the work of Henry Cowell and George Crumb, the contemporary improvising pianists such as John Tilbury, Keith Tippett, Chris Burn, and many of my musical peers with whom I have worked over the past twelve years.

Thus, it is understandable to claim that free improvisation turned idiomatic as, maybe ironically, within the approach clearly definable approaches and techniques have emerged. From the evaluation of events in free improvisation must be concluded that an idiomatic orientation exists. However, neither the avoidance of references to stylistic icons, nor a recognisable individual style does equate to a "stylistic and idiomatic commitment"[223]. Experienced musicians are able to reinvent their own approaches and techniques as much as they can reintroduce tonal elements and clearly referential motivic material without adopting an idiomatic approach[224]. Such an 'independent' idiom concentrates on the sonic properties, the audible character and events themselves,

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220 Paraphrased Klopstock 2002, 14 (original in German).
221 Prévost 2004, 15.
222 Bailey 1993, 83.
223 Bailey 1993, 83.
224 I.e. John Tilbury's more recent performances and CD releases show how he has developed an improvising style which is capable of dealing with tonality and harmonies which has fully transcended the idiomatic use of harmony and tonal progression.

rather than the relation of sounds arranged horizontally and vertically within the musical framework of defined rhythmical and structural guidelines.[225] It is certainly possible to engage with the music resulting from free improvisation in an idiomatic way; to extract what appears as stylistic idiosyncrasies and perform by arranging these into new arrangements. But it is through the activity itself that the improviser develops a meaningful momentary musical framework by engagement in a dialogue with its material and its current performance situation instead of an arrangement of preselected material. The emerging musical framework during a performance is also not concerned to relate to expectations with regards to audiences. It relates to itself and unfolds as a language that develops its own vocabulary and own semantic possibilities between its contributors. This process is clearly perceivable by the attentive listener and is in itself also a very individualistic process defying general objectives and methodologies. The creativity and novelty that can emerge through such approaches might be considered an interesting element to be isolated and utilised in order to rejuvenate other musical genres. But Bailey, for example, considers the latter attempts nonsensical[226] and stresses that “[f]reely improvised music is different to musics that include improvisation”[227].

There is also an important aspect of dissolving functional relationships between the sounds. Webern’s Klangfarbenmelodie and Cage’s musical philosophy are important precursors, because the timbral composite of sounds becomes the focus, beyond the intention to establish specific relations between pitches and sounds.

The improvising musician engages in a continuous search for sounds and “for the responses that attach to them [...] rather than thinking them up, preparing them and producing them”[228]. The “informal ‘sound’ has power over our emotional responses [because it is] working subliminally rather than on a cultural level.”[229] This statement clarifies the most important aspect in free improvisation: as the performance activity is not relying on concrete cultural references, the musical result presents itself as an abstract organisation of sounds, which is put into context by the listener. This does not imply that musicians might be free of intentions to portray and transmit, but they are

[225] Western music is about an organisation of attacks. The decay phase of sounds, or the quality of its sustain is often neglected in music discussion.
[226] Borgo 2007, 29.
[227] Bailey 1996: interview http://www.efi.group.shef.ac.uk/fulltext/mbailin2.html .
[228] Cardew 2006, 127.
[229] Cardew 2006, 127.

aware of the futile task of delivering specific meaning. Such a musician can only build on the context of the 'now', being aware of the temporality of the event and the context and location. It is an attempt to shape and contribute to the perceived musical discourse. The listener is required to engage with the experience and establish its meaning for him/herself. It is the situation in which "context replaces an explicit score"[230]. Internal influences, like the individual's thought processes and the interactive relationships between performers, are central to this activity; as is awareness of external influences, such as environmental noises, accidental sounds or wilful audience intervention. Each of these issues are of equal importance and musicians and audiences ought to be mindful of them. Environmental noises, i.e. police sirens bleeding into the performance space might find musical reflections in the performance itself. Footsteps of moving members of the audience might be echoed in the rhythmic development. I recall the 'miaowing' and eventual shouting of an audience member during my MPhil/PhD upgrade performance on March 23, 2009[231]. This resulted in moments of dialogue beyond the improvising ensemble and caused an obvious increase of tension in the music. Within improvised music, any attempt to design and influence the context is futile. It hinders and disturbs the possibility of a free flow of material and activities. In such a situation a written score has only been replaced by other means preconditioning the performer's thoughts, to ensure that the musician acts as a protagonist of loosely prescribed events. These concepts might still be open enough to allow the musicians to make decisions about many aspects[232], and one might have one's subjective suspicion that conceptual approaches form the fundamental motivation in many strains of improvisation: Although this might not necessarily be apparent, a performance can appear to be freely improvised, despite presenting carefully prepared musical material. For example, one might witness structural explorations more akin to open forms, which remain in the 'safety' of preconceived ideas relying on the false confidence that through such self-determined preselection and limitation one's musical responses will be suitable. Such an approach might actually cause self-criticism, i.e. realising that the music would have benefitted from a further and more consistent exploration of material in different directions (realising that staying in a particular musical place for longer, a more refined execution, or a rawer and bolder approach might have been more

[230] Cardew 2006, 128.
[231] File 2009-03-23_MPhilPhDupgradeConcert.mp3 on Data-DVD.
[232] The balance between mimesis and poiesis in favour of mimesis. Dell 2002.

interesting). From this might follow that one adapts one's approaches for future events. But equally, this could happen within the performance itself. However, one ought to be reminded of Eddie Prévost's statement that improvisation constitutes "'problem-solving' *within* the activity of performance", which includes "the creative and inter-active dialogical relationship between the players"[233] in the moment of playing. Preconception entails resolving musical problems before they emerge in performance itself so that these are employed "as a medium between the different instrumental [and musical] parts"[234]. This makes it impossible to "renew or change the known and so provoke an openendedness which by definition is not possible in an idiomatic improvisation".[235]

Idiomatic forms of improvisation deal with the logic of the material on which the improvisation has been based. Free improvisation, on the other hand, explores the logic and attempts to handle the illogical within the musical dialogue. This results in a different coherence in the musical form. It scrutinises the evaluation of its outcomes in comparison to analytical methods and the approaches established to deal with composed works. Various degrees of harmonicity and rhythmic synchronicity emerge during the emerging states of musical activity, which can be regarded as musical states of distance, gradual approximation and proximity. The beauty and sophisticated qualities of improvisations are not only perceivable through the purely musical, but also by the appreciation of how the musical dialogue finds its solutions to previously detected problems. The method is as important as the result. 'Magical' musical moments can emerge from prior struggle and uncertainty. Isolating this musical moment might just remove its magic, as it is merely a snapshot of the possible.[236] The social cannot be left aside in the moment of the performance, as much as it cannot be included in the cases of recorded events consumed within a dislocated context and temporality.

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[233] Prévost in Cardew 2006, 295.
[234] Prévost in Cardew 2006, 295.
[235] Bailey 1992, 142.
[236] This problem is most prevalent when considering recorded performances for releases, i.e. does one attempt to include the musical journey towards a great musical moment, or ought a release focus on the recorded material as a new musically isolated entity.

3.6. Reductionist Approach to Improvisatory Musical Activity

A reduction of the underlying processes of improvisation can be distilled to a loop consisting of three fundamental and interdependent stages. Pressing describes:

1. the information-processing as the input
2. cognitive processing to develop a response
3. motor output – the execution of the response.

This ultimate abstraction does not include aspects of the activity to feed back into the sensory system of our perception. It is therefore described as a "closed-loop"[237]. Feedback introduces more flexibility and constant evaluation and possible adjustments. This changes the system to an "open-loop", which makes the situation instantly more suitable to assess improvised musical performance. It also highlights the importance of listening (the input stage) as a fundamental element to which musical decisions are related within the moment when considering a response. Listening is fundamental for an attentive response to be decided upon. This has been highlighted in many texts of various authors[238]. The assumed cognitive processing of information creates causal relationships between stimulus and response. This model simplifies the potential complexity of decision-making procedures, as it creates a dependency of every sound to its preceding event. In this manner, Pressing's three stage model has much resemblance to descriptions of mechanical processes[239], in particular those required for the development and engineering of machines[240]. However, descriptions inspired and derived from mechanical cycles to elucidate the order of events are problematic: The neurobiologist Gerald Hüther warns that "adapting technical logic into humanistic processes is of limited use: mostly incomplete, sometimes problematic, and in many ways frankly wrong"[241]. Such reductionistic views of cause and response are also criticised by Julius Kuhl as too simplistic in his physiological theory of personality[242].

One problem of the reduced "open-loop" model is the quasi-mechanical link between listening and response activity, as if each loop would be a single stroke of cognitive processing. While this approach allows to integrate aspects of problem, adaptiveness

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[237] Pressing in Sloboda 1988, 129.
[238] Bailey, Cardew, Lewis, Oliveros, Parker, Prévost, Rzewski, Leo Smith, John Stevens to mention a few.
[239] As in Rowe 1992: the three stages of an interactive music system: sensing, processing, response.
[240] The essential machine structure of input–process–output; i.e. as described by Blackwell/Young (2004) as the p-f-q structure.
[241] Hüther 2006, 2nd lecture 23:00min (used quote transcribed and translated by SL).
[242] Kuhl 2001.

and spontaneity to response to the current event, it struggles to incorporate non-liner aspects of personal intension, endeavour and possible hypothesis of heuristic and social engagement. The model relies on an underlying assumption of linear time progression: one loop is followed by the next, like one piece connects to the next in a chain. Non-linear aspects of personal knowledge and experience can only be compressed into a single moment in time. But constricting cognitive processes into a single stroke of cognitive processing is only appropriate when the mechanics of interaction are considered It is, however, insufficient to describe results of improvisations retrospectively, in particular when the coherencies emerge and unfold over longer sections or even the entire duration of a performance. To tackle these shortcomings, Paine combines the interactive models offered by Rowe[243] and Winkler[244], which in themselves adopt the simplified mechanical model as used by Pressing. In the advance to find further outlines of suitable models for interactive systems Paine refocuses on the characteristics of human conversations. What is "unique and personal to those individuals, unique to that moment of interaction, [...]" offers us fundamentally different sense of interaction. It "is extremely dynamic, [...] constantly monitoring the responses of the other [... ,] to make alterations to their own response strategy" [245] . But for all these open loop models, the incorporation of experience and knowledge remains less coherent. The acquired skill and technique through practice, personal attitude and emotional situation, as well as cultural and sociopolitical issues, constitute the element for the human "total memory"[246]. Our memory stores experience and knowledge in a nonlinear way. Dell's discussion implicates mechanical simplicity when he states that only the

> "process of making rational decisions is linear. Like the mode of operation of the computer they go from A to B and then from B to C. Rational thinking divides the activity in a series of partial operations, which are then combined for the final result. Rationality can therefore only process a part of our total knowledge."[247]

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[243] Rowe 1993.
[244] Winkler 1998.
[245] Paine 2002, 297.
[246] Dell 2002, 197.
[247] Dell 2002, 197: "Rationale Entscheidungsfindung funktioniert linear. Wie die Arbeitsweise eines Computers geht sie von A nach B und von B nach C. Das rationale Denken unterteilt die Handlung in eine Abfolge von Teiloperationen, die dann abschließend zu einem Endergebnis zusammengesetzt werden. So kann die Rationalitat immer nur einen Teil unseres totalen Wissens prozessieren." Translation by Elke Schwarz.

The chronology of experiences is only relevant when acquiring knowledge. In the moment of an activity time has no relevance. The knowledge and experience that enable intuition and feeling within the moment relies on our "total knowledge, of all of what we are and what surrounds us"[248]. Dell speaks of "the suddenness of the improvisatory activity [that] condenses the maximum of knowledge in a minimum of time."[249] Time-tagging memories is an abstract concept because subjective perception of time varies. Simultaneously present multiple time layers[250] occur while decisions are made, establishing more fluid and loose interconnections (reduced rationality) and being influenced from constantly flowing and changing impetus: sympathy and antipathy, references and departures, and introversion and extraversion are within constant flux.

Pressing refines the proposed formula by incorporating memory and the interaction between different players into the equation. The inclusion of elaborate feedback offers valid insights into musical cognitive processes of a particular moment. His model does not, however, overcome the linearity in the process because the adaptations remain elaborations of the initial open-loop model, which fail most clearly when multiple layers of simultaneous thoughts and ideas are considered. The multiplicity of thoughts – not just between different players, but equally in the thoughts of the single performer – is fundamental to the process which results in the emerging sound. A crucial aspect of improvisation is the non-linear links between observations made in the moment and the cognitive mental processes utilising the conscious and unconscious memory in its totality while considering conscious intentions and directions. The momentary response does not necessarily relate to a single thought from the multiple possible responses one might have had in mind. Sarath's discussion is capable of tackling such multiplicities. He speaks of "projected possibilities" which result from "inward strokes". The "initial impulse to create, in which the conscious mind connects with realms of internal imaginary and the internal reservoir" ("total memory"). From these the actual result ("outward stroke"), the "expression of such imagery in the materials and gestures of one's discipline"[251], is formed. This "alternative realized"[252] instantly suggests

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[248] Dell 2002, 197-198: "Intuitives Wissen [...] geht von einem totalen Wissen aus, von allem, was wir sind und was uns umgibt." Translation by Elke Schwarz.
[249] Dell 2002, 73: "In dieser Plötzlichkeit des improvisatorischen Handelns konzentriert sich ein Maximum an Wissen in einem Minimum an Zeit." Translation by Elke Schwarz.
[250] Dell 2002, a concept which also has been fundamental in Sarath's discussion (Sarath 1996).
[251] Sarath 1996, 8.
[252] Sarath 1996, 10.

alternative possibilities through the next turn of inward strokes. Therefore, the cognitive event cycles of inward and outward strokes are "mediated [...] by actuality, possibility and probability conceptions"[253] and within each cycle a field of possibilities emerges that has a causal link to the listening process. Cultural and educational background comes into play, as well as the human "reflexive capacity"[254] in conscious processes through self-reference. Sarath indicates that improvisation restricted to "patterns and coded in [the performer's] physical-conceptual apparatus [...] shroud his or her creative and interactive potential"[255]. Such restrictions occur when the performer has "lost access to the tool quality of freedom from and access to [... a] heightened consciousness" [256].

There is a crucial difference between "ordinary consciousness", where we perceive time as a chain of events from past to future, and the "heightened consciousness" in which we are "subsume[d] within an eternal presence"[257]. Sarath also draws a distinction between the ordinary self-consciousness where we perceive the self "as distinct from others" as opposed to a "personal self subsumed within unbounded self"[258]. Hereby Sarath shows a clear awareness that more complex "routines" are required to account for creative potential. By contrast, Agamben's discourse on potentiality offers a different angle. Rather than finding a model for the individual creativity underlying the activity itself, he highlights how human activity is generally defined through potentiality defined within a range of outcomes. Human activity is contingent and moves between different possibilities as it is to explore the potential of performance during an improvisation. We continuously have the chance to engage in activities that encompass the "potential thought," the possibility of "thinking a thought" and "thinking of a potentiality"[259].

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[253] Sarath 1996, 8.
[254] Sarath 1996, 12.
[255] Sarath 1996, 14.
[256] Sarath 1996, 14.
[257] Sarath 1996, 16.
[258] Sarath 1996, 16.
[259] Agamben 1999, 250.

3.7. The Potential

In reference to Chapter 2 we return to look at instrumental properties that are in direct control of the musician merging the insights taken from Sarath and Agamben. Within the cognitive cycles discussed above, the instrument is the tool for the actualisation of the musical idea as part of the "outward strokes". In other words, it is the tool for musical expression and articulation of intentions, thoughts and feelings. The instrument consists of material enabling musical activity. Material holds consequences that affect the field of possibilities developed during the "inward stroke", because different materials differ in consistency and characteristics. Metal is not like wood, strings are not like surfaces and planes behave differently from tubes. The surfaces, the inherent friction, the given length and thickness all offer opportunities; to initiate, experience and modify vibrations.

A particular discipline is required to explore the full potential of the instrument and search for possibilities strategically. This process is deeply heuristic, based on curiosity and anticipation, develops from intentional and informed investigation. These processes are usually considered the means to learn the potential of an instrument and of musical performance and are therefore often carried out in isolation as individual preparation and practice. However, this contradicts Agamben's definition of "Potential": For him this emerges from "one's own lack, to be in relation to one's own incapacity. Beings that exist in the mode of potentiality are capable of their own impotentiality; and only in this way do they become potential."[260]

Potentiality within performance exists in terms of "to do" and "not to do". There is a fundamental freedom when a possible response has been formulated: final decisions are always made in relation to other alternative possibilities. Thinking about and considering the consequences of one's response within each moment can slow down one's reaction time. However, there is the chance that personal responsibility and integrity of the activity is increased.

Potentiality is defined as an awareness of incompletion, in Agamben's words, "potentiality maintains itself in relation to its own privation [...], its own non-Being"[261].

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[260] Agamben 1999, 183.
[261] Agamben 1999, 182.

The actualisation erases its potentiality. A completed performance and a recording thereof are only testimony of actualisation. Repeating a preconceived arrangement of musical events or basing a performance on rehearsed components reduces the potentiality. An improvisation can maintain its creative energy through continuous exploration. Investigation is the route to discover potentiality and to be "capable of [one's] own impotentiality"[262] is to allow oneself to strive for the unexpected. These qualities are fundamental to a reflective form of improvisation goes beyond personal caprice and whim. "To be free is not simply to have the power to do this or that thing, nor is it simply to have the power to refuse to do this or that thing"[263]. In contrast, an intrinsic quality of human nature is to be free "in the sense [...] to be capable of their own impotentiality, to be in relation to one's own privation"[264].

Again one ought to consider Prévost's concept of self-invention[265] through which the performer develops a sense of what may be possible. In such a case performance is seen as an all-encompassing and inclusive event emerging from the sonic potential of the instrument via the performer's approaches, processes and responses. This potential is embedded and constituted within the relationship between the performer and the instrument. The performer and instrument forming an intrinsic unit, enabling previously acquired skills, positive and negative experiences, intuitively felt possibilities and limitations to manifest themselves through the musician's personality, motivation and creativity. This is a positive, but highly complex constellation of human imagination, responses and instrumental possibilities that can be conceptualised within a potentiality space: A space populated with potential approaches, processes and responses embodies more than what is known. In the words of Bergson: "there is more not less in the possibility of each of the successive states than in their reality."[266]

The conceptual abstraction of a spherical space facilitates also the consideration that the content is not static. The content – representing the potentiality – has continuously changing relationships to each other because any described state is only in relation to a wider continuum. This abstraction avoids the objectification and reduction of human

[262] Agamben 1999, 182.
[263] Agamben 1999, 183.
[264] Agamben 1999, 183.
[265] Prévost 1995, 20.
[266] Bergson 1992, 100.

activity into an algorithmic construct, which at best can only model specific responses. Potential space does not suggest linear hierarchies and orders and therefore retains a fundamental flexibility with intertwined constellations of varying degrees. A considered form of improvisation could offer us a model where there is within a continuous "training instead of rehearsal".[267]

3.8. Aspects on Learning

Neurobiological research by Gerald Hüther[268] outlines fundamental conditions for the learning process. Successful maturation depends upon repetitive routines to acquire life-supporting skills within stable and secure environments. However, in order to develop one's full potential, exposure to new challenges with uncertain outcomes is required. One needs to learn how to deal with risks. Hüther refers to the "optimal flow" [269] when the brain is stimulated by a variety of impulses to make the different centres work with the best potential. He shows that the human brain is not a device to repeat memorised activities continuously, but a device to solve problems, disregarding whether these are encountered as life-threatening or simply as part of a game. Cognitive behaviour suggest that the brain is in need of unfamiliar and stimulating situations to be able to grow and learn from new experiences[270]. The learning process of each is as unique as a fingerprint. The distinction between learning processes based on given and repeated directions and free unguided explorations exposing the person to engage in problem-solving is a balancing act. Environments too secure and predictable diminish potential development while completely chaotic environments fail to encourage an awareness of reason and purpose.

Previous explanations of psychological processes suggested combinations of stimuli and reactions learned over time. Personality was explained by a reductionist collection of cognitive, emotional and motoric dispositions[271]. More recent approaches acknowledge a higher complexity as they attempt to tackle the difficulties to incorporate

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[267] Cardew 2006, 126.
[268] Hüther 2006.
[269] Although Hüther does not make direct reference, there are some similarities to the "flow" described by Csikszentmihalyi, M. *Finding Flow* (1997).
[270] This process can be compared to the reflexive form mentioned above in connection to Agamben and Sarath.
[271] See previous quotes by Hüther and Kuhl (footnotes 241 and 242).

behavioural motivation. Different forms of conditioning can divert and alter the perception of situations and contexts that influence the motivation to engage in an activity. This is shown by Julius Kuhl with the example that receiving rewards for the successful (positive) outcome of an activity can potentially prevent the development of a motivation for the activity itself. If the prospect of receiving a reward motivates an activity, it is likely to trigger a preconditioned response. This diverts the focus from the activity itself and eliminates potential enjoyment and motivation.[272]

When one considers how a human being accumulates experiences and expands knowledge, how information is stored, retrieved, remembered, forgotten, unburied, pushed aside or possibly ignored, one realises that memory is free from time aspects. What one might remember that a certain event preceded another or that it was only possible after something else had occurred. Time is an abstract element for our memory; linear chronological progression is eventually irrelevant, once the information or knowledge has been included in our "total knowledge"[273], and initial causal relationships are overthrown. It is therefore necessary to establish the non-linearity in thought processes in more detail, for which Kuhl's psychological PSI-theory on human motivation and behaviour offers interesting insights for this discussion without claiming to unravel the actual cognitive processes.

3.9. Non-Linearity in Thought (PSI-theory)

Julius Kuhl's discourse compares a large number of psychological studies concerned with learning, human motivation and behaviour. He develops from these the Personality Systems Interaction (PSI) theory[274]. This offers valuable insights into the cognitive and creative processes that can be transferred to the discussion about improvisation. His theory outlines the organisation and processes involved when thinking. Most relevant is the categorisation of brain activity into four parts[275]: "Intention Memory" (IM) responsible to "store intentions"; "Intuitive Behaviour System" (IBS) which "enacts intentions"; the "Object Recognition System" (ORS) "perceives information that is

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[272] Kuhl 2001, 102-103.
[273] Dell 2002, 197.
[274] Kuhl 2001.
[275] Although these devisions resemble in parts the more common categorisation into "left and right hemisphere" of the brain, it is not imperative to assume that this needs to be the case.

discrepant with personal needs and expectations"; and the "Extension Memory" (EM) "that comprises these personal expectations and integrates respective discrepancies"[276]. The parallel processing ability of the brain is largely attributed to the EM and forms the basis of our creative thought. This constitutes the multitude of experiences available for the creative activities, enabling quick responses to holistic observations derived from the entire knowledge and experience. The IM, by contrast, only processes thoughts serially. The IM is attributed to facilitate conscious planning and intentions and is fundamental to problem-solving and learning. Perception and motor controls, constituted within ORS and IBS are closely networked to the IM and EM, and the entire system is regulated by what Kuhl describes as positive and negative affects.[277]

An up-regulated positive affect A+ and down-regulated negative affect A(–) optimises a collaboration of EM and IBS[278] facilitating the holistic processing of existing experiences to enact motoric responses which feel intuitive and occur quasi-instantly.

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[276] Terminology adopted from Quirin 2005, 5: [The first chapter of the PhD thesis written in English was used to decide on the English translations of the PSI terminology. It also appears the most comprehensive English outline of the PSI theory to date.]

[277] from Quirin 2005, 9: This figure and annotation shows the schematic outline of the PSI theory.

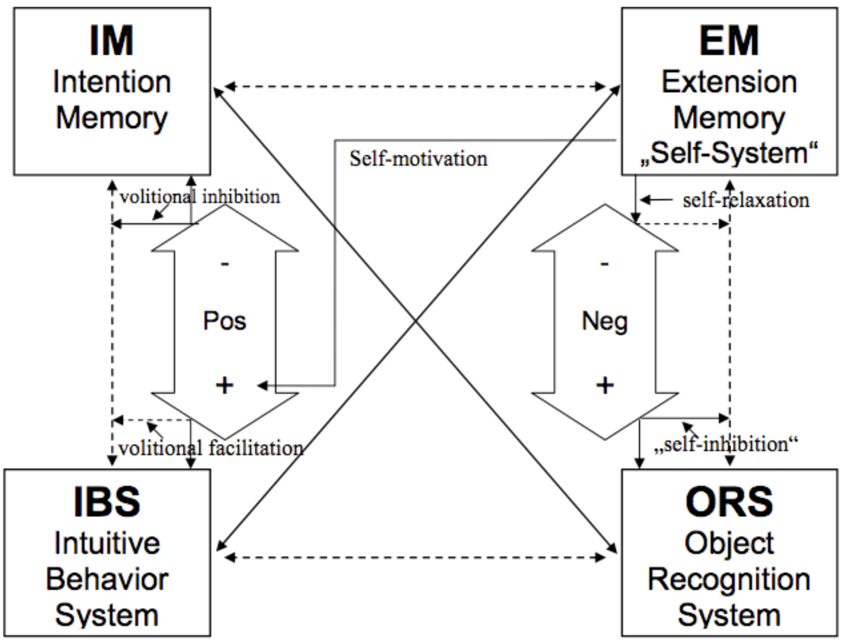

Figure 1

Schematic depiction of the relationships between the cognitive systems and the modulation by positive (reward system) and negative (punishment system) affect

Notes. ---- = inhibitory connection; ___ = facilitatory connection; Pos = positive affect/reward system; Neg = negative affect/ punishment system; -/+ = down/upregulation of positive or negative affect, respectively; to keep the illustration simple, only selected relationships are depicted.

[278] The abbreviations are introduced here as they are used by Kuhl in the figure displayed in footnote 280 and differ slightly from the abbreviations used in the figure above (footnote 277). Up-regulated and down-regulated positive affect: A+ is the same as Pos + and A(+) equals Pos –. Same applies for up-regulated and down-regulated negative affect: A– is the same as Neg + and A(–) equals Neg –.

As stated above the EM is capable of combining previously accumulated knowledge on a largely subconscious level. This processes, utilising the parallel processing capabilities of the EM, can be attributed as a form of creativity. The creative output is the result of a synthesis from elements of our total knowledge into something new. When this result is perceived and evaluated as appropriate for the current situation, the positive affect A+ is increased further. A sequence of such activities can feel as if one is 'being on a roll', because suitable responses emerge effortlessly while one is at ease with oneself and the surrounding. Although this positive and creative state of mind might appear as a perfect state for a musician to be in, it has to be noted that any state of A(-)[279] decreases activity of ORS and IM. As a consequence, any patterns and repetitions that might appear through this activity are less likely to be perceived and as a result the problem solving capabilities of the IM are not being employed.

An up-regulated negative affect A– and down-regulated positive affect A(+) enhances perception of objects and patterns, fundamental to the use of the serially working problem-solving capabilities of the IM. As stated above, this has been defined as a fundamental element in the learning experience and is therefore necessary to allow real progress and continuation to expand the total knowledge of the person. Although this is a suitable condition for an improvising musician, one has to consider that an exclusive focus on the problem-solving capabilities would be counter productive, as it would hinder the person to draw from previous experiences.

As a result the optimal state, the "optimal flow", occurs when all parts are regulated efficiently and effectively by the two affect systems. Any tendency to swing the balance to either of its possible extremes results in distinct behavioural abnormalities: A person relying too much on the EM/IBS can be detected as the dreamer who has difficulties dealing with problems and realising ideas. Whereas a person ignoring external influences while being absorbed in the activity reveals an overuse of the IM/ORS. An incapability to function while remaining responsive and able to deal with distractions will be noticeable as a lack of attention to the surrounding, an absence of inter-social skills, and through their attempts to control every aspect of their environment. Kuhl has

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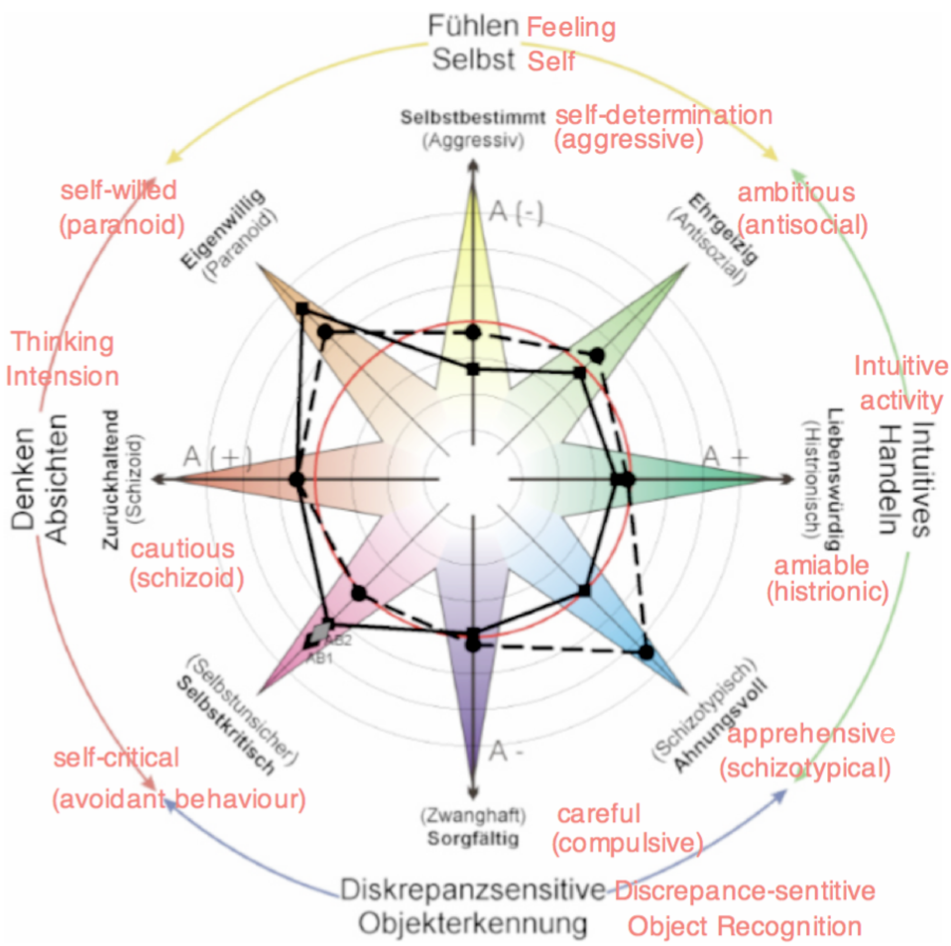
[279] Down-regulated negative affect.

offered a detailed, yet very comprehensive, chart[280] outlining characteristics of our human behaviour. It also shows how an imbalance towards a singular state can turn positive human characteristics into symptoms of abnormalities and possibly even mental illnesses.

The PSI theory suggests the non-linearity of the creative thought and the continuously changing relationships between the different parts and their evaluation. The persistent and frequent interplay and exchange of information between these opposing types of processes is a fundamental prerequisite for improvisation, especially if performances consciously focus on aspects of interactivity with other musicians and the instrument and material. This quest for continuous "self-invention" stands in stark contrast to performance which allows itself to depend on a repertoire of previously developed and trained responses. They do not rely exclusively on a creativity that emerges from the holistic processes within defined musical idioms, but also focus on aspects of an activity

[280] Kuhl 2001: The figure relates behavioural characteristics to the balance between the two affect systems. It indicates how imbalance towards a singular state can turn the optimal flow to symptoms of mental illnesses. Everything outside the red circle becomes what is indicated in the brackets rather than the positive characteristic printed in bold. For example: self determination turning into aggressive behaviour, ambition turning into antisocial behaviour etc. Translations supplied in red by SL.



to find new aspects in the conscious and focused attention to all social, personal and instrumental aspects involved. The ability to transfer "unfinished thoughts"[281] from the IM to the EM facilitates this continuous exchange between intentions and "parallel holistic processing". Acquiring skills and developing a thorough knowledge about sounds, materials and the relations between them, reflect this described process. While research and practice predominantly involve the IM the results are (whether considered final or not) stored in the EM as experiences or "unfinished thoughts". In a performance, the parallel processes ascribed to the EM would facilitate a creative employment of the acquired knowledge and experiences. This would also explain the existence of multiple "projected possibilities"[282] from which one's activity is emerging. While the IM might be employed to search consciously for alternatives and variations, facilitating methodological investigation of sounds and materials, including testing and scrutinising their affects on the musical proceedings. These aspects of cognitive processes appear to describe the personal experiences gained in the practice of free improvisation more accurately: The responses of improvisers are not necessarily reducible to a single possible cognitive response; actual responses can be based on several individual ideas within different time scales. At any moment several different ideas can emerge that find eventual "actualisation" through additional layers of evaluation, within conscious compound constructs, fragmented collages, and other forms of deliberate combinations. During an improvisation the cognitive processes involving intuitive and conscious levels are constantly changing, as well as the degree of self-reflection about the significance and importance of one's responses, the attention and alertness, or even what just appears compelling or challenging of what is considered possible, are in continuous flux.

When revisiting idiomatic improvisation with these insights, a different perspective is possible. Idiomatic improvisation favours – even requires enhanced activity of – the EM and IBS which requires a high positive affect. Rather than focusing on genre specific musical idioms perhaps idiomatic improvisation is relying on a high activity of the EM, because idioms are references existing in the pool of accumulated knowledge and experience of the performer. Jazz improvisation utilises melody and harmony in studied and internalised patterns that are explored and combined in potentially novel ways. New

[281] Kuhl 2001.
[282] Sarath 1996, 8.

ideas develop by going beyond the learned, indicating holistic processing capabilities. The same can be said about performances which refer to a personal idiom developed over time, perhaps loosing aspects of searching for new aspects of one's music, instead relying on the nuances appearing within the continuous work with settled approaches and techniques. A "feel-good factor" gives the "improvisers experience a great sense of relaxation, which increases their powers of expression and imagination. They handle their instruments with athletic finesse"[283]. Such instances are evident from biographic information and anecdotes about many musicians[284], in particular when their music served as an escape from every-day difficulties and they admitted to a deliberate exploration of drugs to reach enhanced state of minds. The EM can also serve as an explanation of physical and mental virtuosity, as the close link to the IBS facilitates the fast responses and adjustments during performance that leave spectators astounded. Kuhl's theory suggests that in such a situation, which is facilitated by the high positive affect, limits innovation, because the IM is inhibited by positive feeling. "The more immediate and behavioural routine is bound to its executed system, i.e. the more impulsive its relation occurs, the more hasty and less elaborated it probably is."[285] It is the negative affect that stimulates the development of new responses and solutions: the performer requires an urge to go beyond themselves and to actively question their own activity. It is here where the quoted importance of "failure"[286] and "making the right mistakes"[287] has its significance in improvisation: the moment in which the initial intention has not been realised the increasing negative effect will result in a more conscious creative activity. Kuhl describes the negative affect not only as the opposite of positive affect but as an independent regulatory system. It is therefore possible to maintain a conscious and deliberate scrutiny while achieving levels of positive feeling. It becomes clear that the PSI theory supports the idea of maintaining a balanced attitude within the complexities of human behaviour and motivation rather than giving concrete pathways to achieve maximum creative results.

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283 Berliner 1994, 389.

284 See also Sawyer 2003, 42-45.

285 Kuhl 2001, 104: "Je unmittelbarer eine Verhaltensroutine an ausführungsbahnende Systeme angebunden ist, d.h., je impulsiver sie ausgeführt wird, desto flüchtiger, d.h., desto weniger elaboriert dürfte sie sein." Translation by Elke Schwarz.

286 Morton Feldman: "For art to succeed, its creator must fail." Friedman 2000, 27.

287 Quote attributed to Thelonious Monk: "I made the wrong mistakes. Making music is all about making the right mistakes." Feurzeig (2011) indicates that this is "almost certainly a misquotation, though of an authentic Monk remark". Feurzeig 2011, 54.

There is free improvisation that searches for the positive emotions to unlock the creative potential of the EM, and free improvisation that approaches "self-invention" showing a high interest in the "reflexive"[288] forms emerging from performance activity. The latter is seen as fundamental for this discussion: as it is geared towards the intention memory, it develops techniques for the moment utilising previous experiences, approaches and strategies, rather than relying on previously developed constructions and outcomes. An understanding of performance goes beyond the arrangement of previously developed techniques and sound repertoire within a time structure. It can also focus more actively on the search for further musical potential of activity. The known sound, i.e. scraping a piece of rubber on the strings of the piano producing a high-pitched whistling sound, can be placed and repeated at any suitable position in time. However, it can only be seen as the starting point for an active exploration, to see what further variations can be produced, and ultimately which of these new qualities might lead to completely new sounds showing entirely different characteristics. When exploration is not restricted to the search for new sonic qualities in the practice room, to prepare for performance eventualities, but sought during the performance itself, then new approaches and meanings can be found within performance structure and ensemble interaction. The social component is important because within a free improvisation musicians are not given specific musical functions as is the case in idiomatic music genres. Within the improvisation musicians have to find and scrutinise their place within every moment of time.

The complexities of freely improvised performance reflect the complexities of human behaviour. While Kuhl's psychological insights suggests the non-linearity of cognitive processes, Agamben's discourse into potentiality exposes that human activity allows to think potentiality. Human thought goes always beyond the actualised – in terms of musical performance – human thought goes beyond what has been performed. Chapter 5 will form a continuation by introducing spherical abstraction of personal concerns in relation to the proposed performance practice. For this, however, conceptional and technical aspects of the developed performance system *piano+* ought to be described (Chapter 4) which reflect the approach to improvisation described above.

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[288] Used here in the Agambian definition (footnote 217).

Chapter 4: Technical Implementation – *piano+*

This chapter describes the current my design of the performance system *piano+* which has been developed by myself while concurrently undertaking the theoretical research presented in this thesis. Although this is not a comprehensive manual for the performance system, a discussion of its features is required because they are integral to my performance practice and constitute part of this research. The significance in general of engaging in instrument design has been outlined in previous chapters. The metaphor of an onion can be used to describe the conceptual design of the *piano+*. The acoustic piano is the core and extended acoustic techniques and the technical augmentation form the surrounding layers. In order to outline the key approaches, techniques and processes used, the discussion will consider material, gesture, touch and computer-specific issues such as suitable electroacoustic processes and parameter mapping. Although these have been discussed in detail by various researchers they remain a centrepiece for any design of computer-assisted augmentation. The chapter culminates in a description of a novel, triple controller system employed within the *piano+* and some prototypes partially implemented in the current version. These will further exemplify the impact of the theoretical work on the concepts within the programming strategies.

4.1. *piano+*

The *piano+* is a performance system based around a conventional acoustic piano. The sonic possibilities of the acoustic piano include those available through extended techniques and preparations. For this reasons a grand piano is considered the first choice, although performance on an upright piano is possible[289]. The system would allow the use of any acoustic instrument[290], although the development focused on the piano, so functions might therefore be less effective for certain acoustic properties of other instruments.

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[289] I.e. performance from the 20.08.2011 Solos series: Sebastian Lexer (*piano+*): Madame Lillie's, 10 Casanove Road, Stoke Newington N16, London, UK, http://solosets.co.uk .

[290] Blase_25:34 on *Blasen* (Lexer and Wright 2008), experimental sessions with Seymour Wright in Summer 2006 and John Butcher in Autumn 2009 (Audio example: 2008-10-31_ButcherLexer.wav (3:18 - 10:30min).

The insights on the principles of vertical and horizontal sound modifications developed in Section 2.3.1 have influenced the limitation on five electroacoustic processes which are currently implemented[291]: Two granulation modules[292] to playback audio material independent of pitch, position and duration. A pitch modulator[293] allows to change the frequency content of the audio signal, either by adding sidebands to the live signal or by transpositions. A filter module[294] which was designed to produce sonic artefacts and glitches, and a partial synthesiser[295] capable to extract and sustain a limited number of overtones of the acoustic timbre.

4.1.1. The Core – the Piano in the *piano*+

The influence of Feldman, Cage and Cardew is evident in my general interest in a sound world concerned with a sparse use of notes and rhythmic material, allowing the sound quality to be fully perceived. The contingent complexities emerging in the decay phase of sounds and the concerns about improvisation as described in Chapter 3 explain why the musical interest shifted away from the focus of organised attacks, interrelationships of pitches and conventional concepts of harmony. Motivic and rhythmic development have been replaced with the contingency of the sounds themselves and the process of their production.

As these contingencies are particularly evident within single and small constellations of notes in a wide range of dynamics, conventional pianistic virtuosity is considered irrelevant – even counterproductive – to the artistic aims underlying this research. Therefore, conventional piano techniques are not outlined, except in reference to touch[296]. Most influential in this respect has been John Tilbury's approach to the piano that he developed when engaging with the music of his friends:

"With the great Feldman players, like David Tudor and Cardew, it is the dialectic of, on the one hand, the extreme fingertip sensitivity and control – embodying the notion of intention – and on the other hand the recognition, through an awareness of the contingent, of the ultimate impossibility, indeed the undesirability of control. Intimately, at close quarters, as it were, the

291 Screenshots of the Max patches are included in the Appendix IV rather than included into the flow of this chapter, this allows all modules to be reviewed in one single place, as well as Appendix V shows the same modules in a earlier version.

292 See Appendix IV, Figure A5 and A6.

293 See Appendix IV, Figure A7.

294 See Appendix IV, Figure A8.

295 See Appendix IV, Figure A9. resonators~ by CNMAT http://cnmat.berkeley.edu/patch/4019).

296 Gieseking, Perlemeuter/Dodek, Schnabel/Wolff etc.

performer experiences the vulnerability of intention and the inevitability, and acceptance, of failure."[297]

This approach has been adopted not only by default – following several years of piano studies with Tilbury – but by personal conviction, as the informed approach and awareness has proven to unlock a more acute perception of the sonic potential of the instrument. Techniques applicable within any genre are concerned with the feel of the surface and weight of the key and action, which maximises control. Tilbury's approach appears unique. He considers the act of striking the piano key as an attempt to control that accepts the contingencies of the activity – rather than to minimise uncontrollable factors. As soon as the hammer has left the repetition lever on its way towards the string, the pianist is stripped of any further control but to release the key or pedal to silence the string with the damper. Everything happening within the duration of the sound is highly contingent, but potentially goes unnoticed by an inattentive listener. The strength, speed, finger shape, arm weight, wrist position etc. are therefore only a means to provoke a particular sound, dynamic and timbre. The pianist can only observe the intrinsic details of the sound unfolding while it decays into the inaudible, a result within a certain range of possibilities. Technical proficiency can narrow the range to make the sound closer to an imagined ideal but the contingent quality remains. Although careful choice of the piano and attempts to ensure consistent tuning and intonation can help to reduce the contingency further, they will never eliminate it.

Developments in piano design are often concerned with creating more consistent instruments to allow more consistent interpretations of the repertoire. However, perceived flaws and inconsistencies in different pianos can be considered positive qualities by the pianist. The sonic idiosyncrasies of different instruments can be explored positively, allowing different interpretations of composed works. In improvised performances such differences can even facilitate particular idiosyncratic directions of one's work. When improvisation focuses on the activity of the moment and incorporates the situation holistically, the instrument becomes fully incorporated with all its qualities and apparent flaws. The instrument therefore becomes the integral element, not for the realisation of preconceived intentions and visions, but as the essence of the musical activity that enables the exploration of the potentiality.

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297 Tilbury 2001.

4.1.2. First 'Surrounding' Layer – Extended Acoustic Piano Techniques

Extended techniques utilise an instrument beyond the established sonic possibilities. Considering the vast possibilities of interacting with the innards of the instrument, it feels inevitable that the acoustic piano ought to be used beyond the conventional way of striking the keys. The tools for such extended techniques are in many respects unlimited, starting with the most obvious – the fingers of the performer – but also any designed or found object can be used, from piano hammers, violin bows, cymbals, bolts, screws, tubes and rubber, applied in gestures of plucking, hitting, striking, stroking, bowing and sliding. The performer engages with materials, their physical consistencies and qualities and researches how placement of preparations and friction between materials result in changes to the timbre – as the overtone structure is altered – or open entirely new sound worlds.

There is no complete overview of possible extended techniques in the form of listing and cataloging objects and techniques, firstly, because of the vast array of potential sound production methods, but more importantly, because it is an ever changing and developing area. It will be more useful to summarise playing techniques, the objects and preparations employed, and their placements in more general terms with an attempt to establish possible grouping of objects and performing gesture.[298] This employs a stylised notation developed for the purpose that focuses on the relationships between gesture, material and method rather than considering the sonic outcome alone.

The figures (M0 - M28) distinguish between different methods that employ extended techniques and have a focus on striking, plucking and stroking. Several of these methods were introduced by Henry Cowell and John Cage and developed by many contemporary composers and improvisers[299], but with regards to specific materials and application within the proposed performance practice, each personal approach shows unique aspects. This selected overview will focus on methods applied to a single pitch in order to draw attention to the differences in approach and sonic variation possible, as demonstrated in the audio examples M0-M28.[300]

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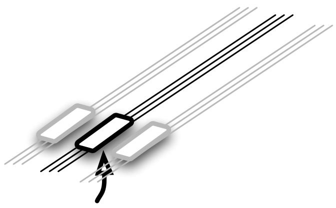
[298] Figures M0 - M28 on page 104-108.

[299] Improvising pianists John Tilbury, Chris Burn, Frédéderic Blondy, Sophy Agnel, Anette Neumann to mention only a few.

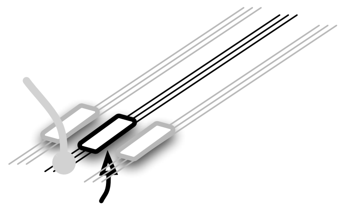
[300] Audio CD *extended technique methods*: track listing in Appendix VI – Audio examples.

4.1.2.1. Extended Techniques

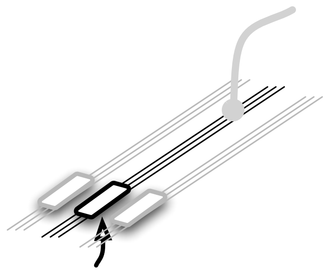
For the purpose of introducing the notation, the conventional piano technique has been included as method M0[301], the highlighted set of strings indicate the sounding strings, and the damper enables a simple orientation for the location of activity. The arrow indicates the point where the hammer strikes the string when the key is depressed.



M0: conventional sound production on the grand piano



M1: muting sound by placing a finger on strings close to the bridge



M2: producing harmonics by placing a finger lightly on the nodes of the string

This first group of methods starts with a gradual deviation from the conventional piano sound. Placement of the finger on the strings[302] will alter the timbre of the sound significantly. A muted sound quality is achieved when the finger is placed in front[303] of the dampers (M1), while harmonics can be produced when the finger lightly touches a node of the string[304] (M2). Placement of the finger and pressure are the crucial aspects to modify the timbre and pitch of the resulting tone.

4.1.2.2. The "Prepared Piano"

Placement of an object[305] and the velocity of key strokes are the sole expressive means for method M3, exemplifying preparation of the strings by placing objects between the strings of the piano.

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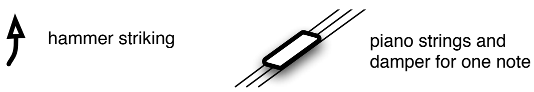
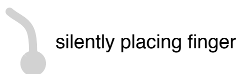
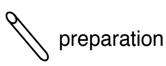
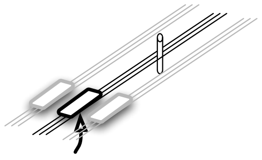
301 

302 

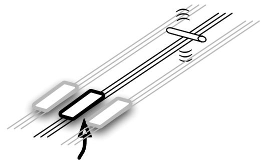
303 Closest to the keyboard of the piano.

304 Nodes are to be found in relation to the length of the string. For example 1/2 results in an octave, 2/3 is a perfect fifth, 3/4 perfect forth. 4/5 is the major and 5/6 the minor third etc.

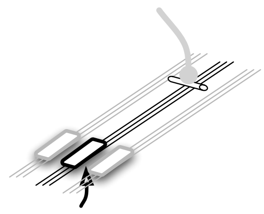
305 



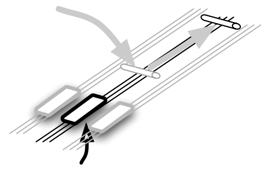
M3: placement of preparation between strings as introduced by John Cage



M4: loosely placing objects on the strings causes additional vibrations



M5: placing and holding an object on the string on the string



M6: placing and sliding object on the string after or while a key is played

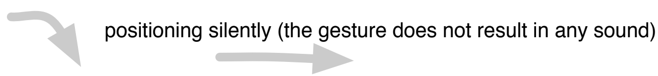
The initial concept of preparing a piano is credited to John Cage turning the piano into a percussive instrument for his composition *Bacchanale*[306]. But placing objects in between the piano strings to change the sound of the piano has vast possibilities for individual exploration. The type of material, its size and position will affect the produced sound, for example, hard objects such as bolts and screws will give a more bell-like timbre, softer materials (e.g. a rubber wedge) will mute the sound. Objects loosely placed will cause a rattle or will even bounce, influencing the decay phase and distorting the sound in varying random ways (M4)[307]. When an object is pressed onto the string (M5) a variation of sounds can be achieved, which can, depending on the material, bear some sonic resemblance to methods M2 and M3. One difference is that the pressure exerted on the object can be varied, giving the performer the means to articulate timbral phrases, which adds an expressive element to the sonic manipulation. Additionally the placement can be changed[308] (M6) which increases timbral, articulative and expressive possibilities even further.

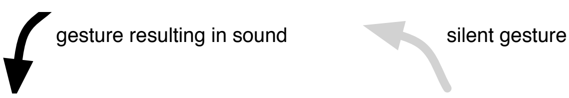
4.1.2.3. The "Inside Piano" – Variants of Plugging and Hitting

Methods M7, M7b, M8 and M8b[309], use the inside of the piano as a harp – a common approach to the piano in free improvisation. The "inside piano" has started to

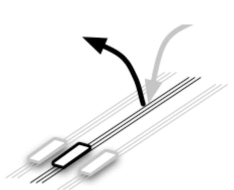
[306] Cage 1938.

[307] M3 and M4 summarise the prepared piano as Cage employs e.g. in the Sonatas and Interludes (1946-1948).

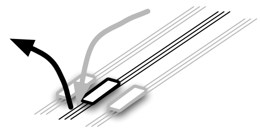
[308] 

[309] 

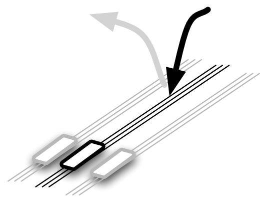
established itself[310], like the “prepared piano” as an instrument reference, rather than the description of the innards of the piano.



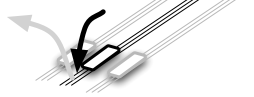
M7: plucking a string behind the damper



M7b: plucking in front of the damper

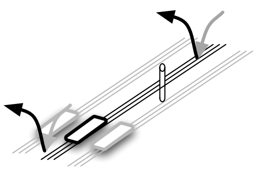


M8: hitting or flicking a string behind the damper

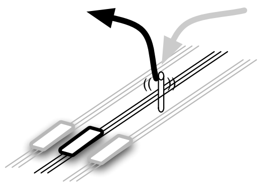


M8b: hitting or flicking in front of the damper

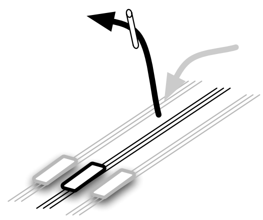
The playing gesture has been conceptually divided into its silent and sound producing parts in order to clarify aspects of the methods presented below. The sound quality varies greatly depending on which part of the finger or hand is used and where the point of contact is in relation to the string length. It is obvious that the softer the pluck, hit or flick is, the softer is the sound. The timbre is more mellow when the finger tips are used and harsher when involving finger nails. Activating the string in the middle (M7 and M8) will produce a fuller and warmer tone while using the node points can enable the enhancement of specific overtones. Plucking, hitting or flicking the strings in front of the dampers will always produce a thinner variation of the sound as the fundamental of the string is weakened considerably (M7b and M8b).



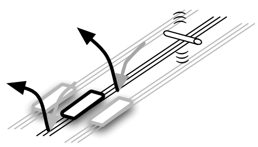
M9: plucking a string with inserted preparation



M10: plucking a preparation



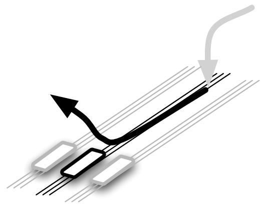
M11: plucking a string with an object



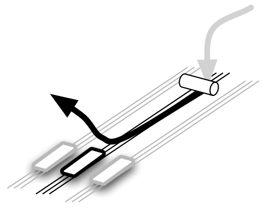
M12: plucking a string with an object loosely placed on it

M9, M10 and M12 are variations of the plucking gesture (M7) involving preparations and can sonically be very close to M3 and M4.

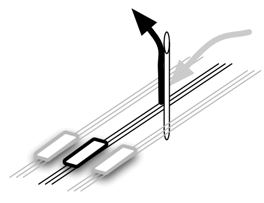
[310] For example: Reinhold Friedl (http://www.hronir.de/Reinhold_Friedl.html) and Andrea Neuman (http://www.japanimprov.com/profiles/aneumann/).



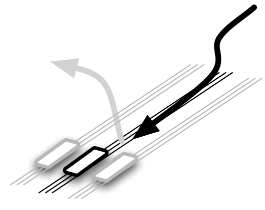
M13: sliding/stroking on string



M14: sliding object on string



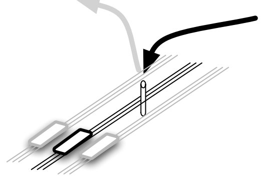
M15: sliding along preparation



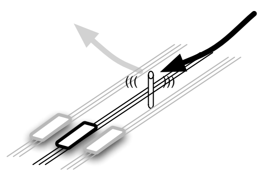
M16: hitting string and sliding

M13-16 regard the silent positioning and the sounding gesture separately and are conceptually more distant variants, or adaptations, of the plucking gesture (M7). This widens the spectrum of relations between different playing methods and establish relationships between the sounds other than through their acoustic properties. In this manner, M13 relates to M7, not by perception of the sonic characteristics of plucking, but because the silent positioning of the hand/finger is followed by a sounding gesture of sliding or stroking along the string[311]. M14 and M15 are further variations, as either an object is used to slide on the string, or vibrations are created by sliding fingers along a preparation (e.g. wooden chopstick). M16 is the reversal of M13, but also a variant of M8 as the hitting and sliding gesture is combined.

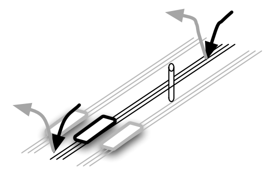
M17, M18, M19 and M20 are variations on M8 (hitting/flicking). M17 and M18 distinguish between a hitting and a flicking gesture, as flicking usually results in an unsteady wobbling of the preparation, while hitting the preparation often gives a very warm and full gong-like sound.



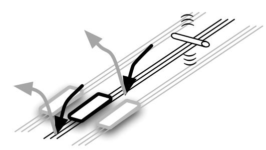
M17: hitting a preparation



M18: flicking a preparation



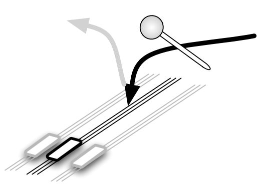
M19: hitting/flicking a string with preparation



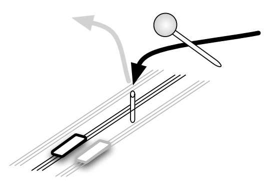
M20: hitting/flicking with an object loosely placed

M21-24 show adaptations of methods using a beater. The material and type of beater will influence the timbre greatly, however, similarities to methods M17-18 will be perceivable, so that the selection of beaters (or fingers/hand) can give a sonic continuity, similar to the continuity drawn on by a percussionist who chooses beaters in relation to the timbral qualities envisaged.

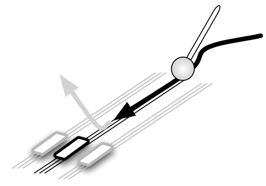
[311] This technique is used in the piano piece *Banshee* (1925) by Henry Cowell.



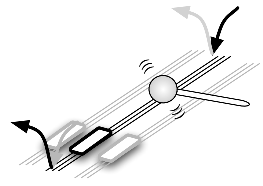
M21: hitting string with beater



M22: hitting preparation with beater



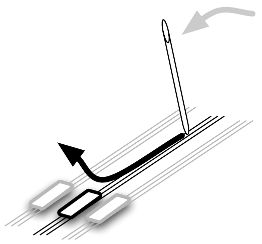
M23: sliding beater on string



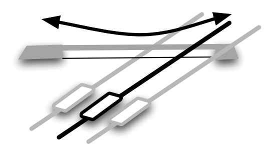
M24: placing beater on string and plucking or hitting the string

4.1.2.4. Complex Variations

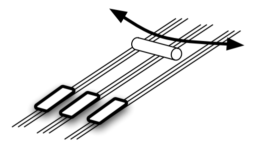
The last group of this overview shows some more ‘special cases’: M25 shows a stick being held loosely and slid on the surface of the strings. A sound reminiscent to the cry of a seagull, which I first encountered in an AMM performance in the hands of John Tilbury[312]. This technique has been developed by many improvising musicians, probably most dramatically (sonically and visually) by Frédéric Blondy, who attaches cans and cymbals at the upper end of the sticks amplifying the timbral qualities and volume[313].



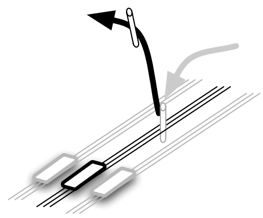
M25: sliding stick on strings



M26: bowing strings



M27: sliding objects on strings



M28: removing a preparation to deliberately make a sound

The grand piano offers only a few places where a bow can be used. M26 shows an effective strategy to bow the lowest single strung register, while M27 also uses a bowing gesture to slide an object across the strings.

The last method displayed (M28) indicates how applying the plucking gesture with different degrees of grip can be another field for sonic exploration. Despite an obvious relation to plucking with an object (see M11) – the sounds will be very similar as soon as the object leaves the string – the friction between the surfaces can result in very

[312] AMM, Conway Hall, 1996 (I attended the concert but am not able to confirm exact date).
[313] Frédéric Blondy uses his technique in the opening minutes of the videoed performance from the 7th July 2008 (http://www.fredericblondy.net/en/69blondyplumet.htm).

elaborate variations ranging from squeaks to forceful scrapes, while the object is still between the strings.

The division of performance gestures into silent and sounding components can be linked conceptually to the operational and performative actions discussed in Chapter 2, in connection with performance technology. Silent gestures are intrinsic to the physical activity of playing, whether they are to position oneself, to pick up an object or to rearrange them. These gestures are easily accepted as part of the performance. This contrasts greatly with the notion of purposeful gestures in live electronic performance, in particular laptop-based performances. The opportunity for conscious and strategic focus on changing performative gestures during performance is considered particularly important for an investigative approach to improvisation: The position, point and consistency of contact, as well as the gesture itself can be gradually varied; this may lead to a continuity in the performance that has not been based on the relation and cohesion between the sounds themselves. For example, one can explore the resulting sonic potential of plucking by applying the same gesture to different points on the strings and preparations. It is also possible to search for variations and adaptations by using different materials to execute the gesture, or altering the sounding component of the gesture to change its character (e.g. plucking turning into stroking, compare methods M7 and M13) and unlock further potential in the process.

4.1.2.5. Linking Gesture Methods To Performances

The following figure (Figure 4.1) illustrates a chain of methods introduced above as a potential performance sequence. This illustration links the methods in terms of gestural variation R1 - R9. It also indicates a few possible projected alternatives A1 - A9.

One aspect of the gesture is varied in each numbered diagram. For instance, the note played conventionally (R1) is muted for R2. The character of the gesture is altered from holding a position to hit the string in R3, and the silent and sonic part of the gesture are reversed turning the hit into a pluck (R4). Lengthening the sounding component changes it to a stroke (R5). Applying the same gesture with one type of object (e.g. sliding chopstick, R6), and using then another (e.g. copper tube, R7). R8 varies this gesture by combining it with hitting, plucking and key-strokes, so the object is used in the way the bottle-neck is used on a guitar, replacing the gesture with bowing (R9) and replacing the object with a bow (R10).

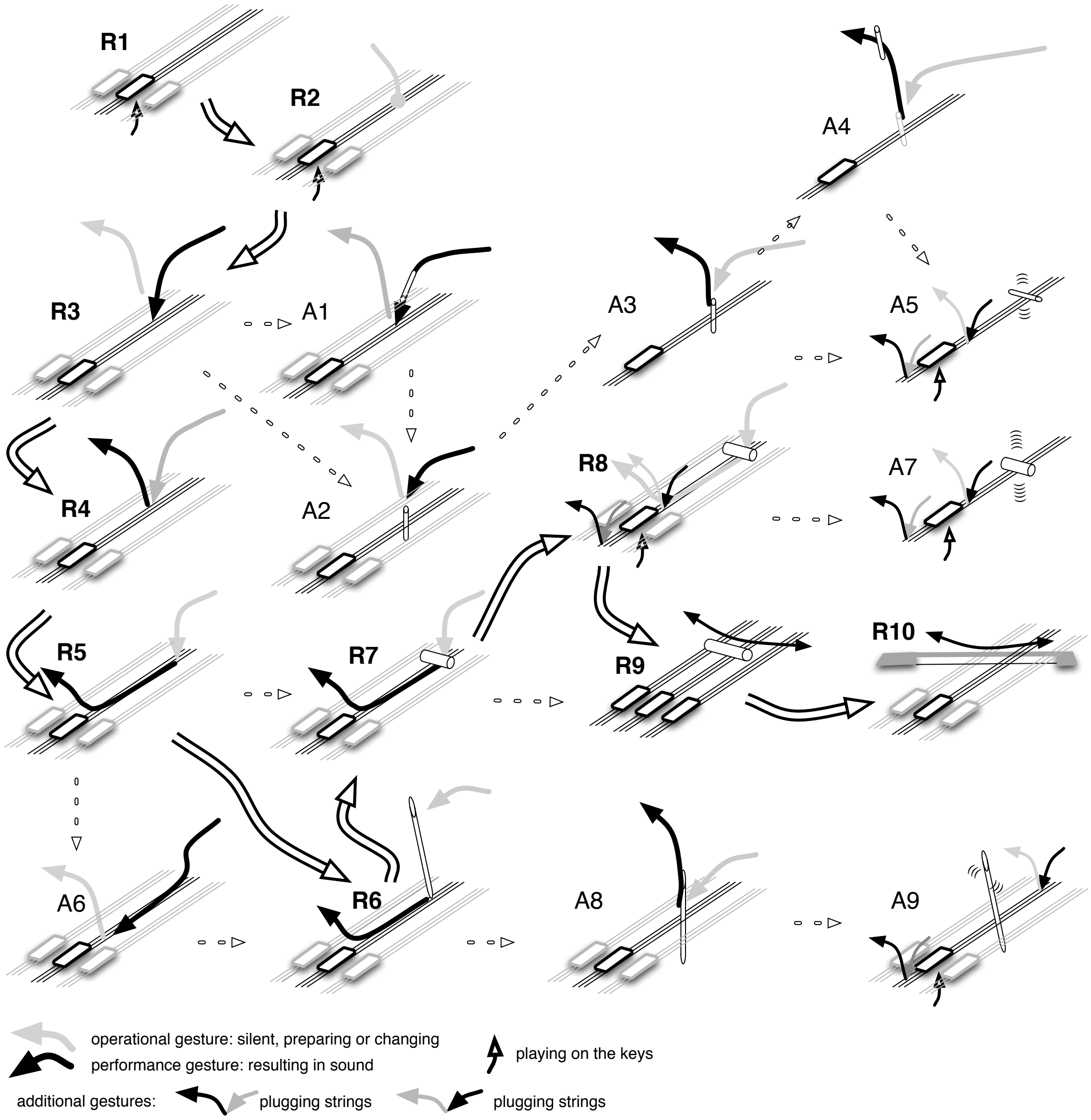


Figure 4.1: Gesture score, including realised methods (R1 - R10) and a selected number of possible alternatives (A1-A5, A6, A7 and A8-A9).

4.1.2.6. Direct and Indirect Involvement in Sound Production

The extended technique methods described above require direct involvement, i.e. the sounds are only produced through physical gestures by the performer. Methods M12, M14 and M20 link to further possibilities which allow sonic results from indirect gestures. For example, the placement of cymbals and other objects on the strings can produce rattles and other small sounds despite having no direct contact with the strings being played. This can be caused by sympathetic vibrations or by deliberately ‘rocking’ the piano. Such indirect sounds might also occur by accident in the while objects are either placed into position intentionally, or replaced and put aside. EBows[314] and vibrating tools enable intentional use of indirect sound production: no physical engagement by the performer is required when placed in the mid-register. EBows might need to be pressed onto the strings to start the oscillation at high-mid-register, and their strength is not sufficient to excite the highest register at all. Their electromagnetic method is also unsuitable for the copper-wound strings of the low-register, because the electromagnetic method works only on steel and despite the steel-core of the low piano strings the strength of the EBow is insufficient to induce the vibrations.

The expansion of the sonic palette gained through these techniques offers further contingencies of sounds that can be specific to a particular instrument. Certain techniques do not work on some pianos while others may have incredible potential. In the spirit of a heuristic improvisational approach, this is not perceived as a restriction but as a chance to refine one's understanding of the process of creating sounds. These situations can highlight the principles of sound production, increasing an understanding of acoustic and physical facts, rather than merely enlarging the sonic repertoire. Learning about materials and experiencing their characteristics, to develop an understanding of how these facilitate sound manipulation is considered crucial here. Such concerns are thought to be as important as structural considerations of how these sounds are arranged over time.

To summarise, this overview of extended techniques indicates the importance of materials, as the methods affect the timbre, the vertical axis of a spectroscope representing sound. The properties of the vibrating and resonating parts of the instrument are modified through physical modification resulting in variation of pitch, partials and amplitude shape. For example, the firmly pressed placement of an object on the string is as if one has added a bridge and shortened the string length. Through the division of silent and sounding gestures a conceptual continuity has been established between extended techniques and operational and performative tasks involving technology. Furthermore it has been shown that within the predominantly direct involvement in sound production some approaches have the scope to result in indirect sound production which can be conceptually linked to the strength of electroacoustic

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[314] EBows (http://www.ebow.com) were developed for the electric guitar and works on a electro-magnetic feedback principle (United State Patent 4075921 dated 28th Feb 1978).

augmentation: the ability to create sound modification extending into the horizontal axis – time.

4.1.3. Second 'Surrounding' Layer – The Electronic Augmentation

Following this descriptive notation of the extended techniques, the technical design of the electroacoustic layer of the *piano*+ is now described in technical detail. The nature of the processes and their controls differ from the extended technique methods, because, depending on the parameter mapping, the controls are not necessarily based on a physical gesture. Although it is considered that a notation would be possible which might find useful application for various purposes, I have decided against it in this context. First of all the processes of the *piano*+ require an acoustic sound, therefore a method for an acoustic sound would be required as basis for coherent continuity. The processes manipulating either the vertical axis (frequencies) or horizontal axis (time) could reflect such changes. Figure 4.2 gives an example of how the sonic modification by a granulation effect could be visualised, illustrating how sections of the acoustic source continue as a slightly blurred and hazy extension of the sound.

Figure 4.2: Possible visual transcription of an electroacoustic process (e.g. granulation)

This example, solely given to attempt a visual continuity of the notation, is purely describing the aural result. Actual information about necessary performance gestures in relation to parameter settings (mapping) of the specific electroacoustic process is absent. If it were to display the parameter settings resulting in such a sound, then it would represent specific value curves of a specific granulator patch. An obvious path to generalise a scoring approach for the processes in coherence with those introduced for extended techniques is not apparent. The notation introduced for extended techniques established a continuum of physical gestures which can be explored in performance. The complexities and diversity in parameter mapping renders a similar approach for the electroacoustic augmentation as vague and too specific to particular setups and controllers and is therefore not pursued.

4.1.3.1. Infrastructure to Focus on Intended Functionality and Practicality

Instead, it is considerations of horizontal and vertical processes as established in Section 2.3.1 that have influenced the selection of processes included in the design of the electronic augmentation of the instrument. The fundamental motivation for my research was the potential of electroacoustic techniques to subvert particular sonic limitations of the piano. For instance the unavoidable decay of the piano notes can be overcome electronically using granular synthesis. The prominent attack phase of the piano can be eliminated with sampling techniques by applying fade-ins to disguise the attacks. The processes utilised within the system will be described later in more detail; however these two examples serve as an indication that the system has been developed to expand existing sounds rather than creating a system which adds additional musical parts intending to replace acoustic playing or fellow musicians with algorithmic processes[315]. From the start of the development of the system it has been a preoccupation that processes have to work in real-time without prerecorded and pre-edited material. This led to the dismissal of certain technology available i.e. the *Disklavier*, conventional sample players or sound design using sophisticated software packages. The exclusion of sophisticated devices and software tools developed in the wide range of electroacoustic fixed media compositions[316] and accurate performance data acquisition through the MIDI protocol might be regarded as an omission with respect to sound-quality and control possibilities. But a system based on MIDI control input is too limiting in practical and logistical terms. The performance opportunities are very rare if one depends on the availability of a *Disklavier* and performance data acquisition would be restricted to conventional playing techniques, as no MIDI data would be transmitted when the performer engages in extended techniques, neither would the data reflect altered pitches of prepared notes. The alternative would be to include an additional keyboard like trigger system or to implement algorithmic processes to enable the use of prerecorded samples, which although explored at various stages through the

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[315] For example: a commercial software to replace ensemble musicians for practicing purposes is Band In A Box (http://www.pgmusic.com/bbmac.features.htm), but also projects such as GenJam by John Al Biles (Miranda and Biles 2007, 137-169) and Voyager by George E. Lewis (Lewis 2000) result in the replacement of acoustic players in favour of generative processes.

[316] E.g. *Trois études en duo* (1991) and *Huit esquisses en duo* (1989) by Jean-Claude Risset for pianist on *Disklavier* with computer interaction. Jonathan Harvey's *Tombeau De Messiaen* (1994) for piano and tape.

development, was eventually dismissed as it contradicted the aesthetic approach and was considered a step too far into generative music composition.[317]

Consequently, *piano+* was primarily developed with real-time sound modifications in mind and much research was directed to optimise parameter management, signal routing, and audio capture. An influential insight was that the type of controls used are far more decisive for the performativity of a computer-based system than the processes themselves. It is the inclusion of control methods that determine the musical paradigms convincingly discussed by Croft[318]. The paradigm of "backdrop"[319] can be established with a minimum of control interaction, i.e. a fixed media piece or triggering suitable samples at specific points in the performance. The “instrumental” paradigm however requires strategies allowing immediate interaction and adaptation, to allow spontaneous changes to the musical situation.

4.1.3.2. Implemented Electroacoustic Processes

As mentioned in the opening of this chapter, the current design of the *piano+* facilitates two granulation modules, a pitch modulator, a filter module and a partial synthesiser to supply sufficient means of vertical and horizontal sound modifications. Practical work and concerns about the exploration of the sonic potential of the instrument as a whole also influenced the final selection. This will be elaborated in Section 4.3.1 when the work and experiences with a live sampling module are described which has not been implemented in the recent design.

The granulation patches were personally built in Max/MSP using *Granular2.5* by Sakonda[320] as a model. The first granulation module[321] allows to control start, length and volume of the grains as well as setting a random factor to modulate the playback position. The content is recorded in real-time, each recording records over the previous material, without clearing the entire buffer. The tail of the previous material remains available for playback, if the recording is re-triggered before filling the entire buffer. The grain speed results in possible transpositions. Minimum record time parameter,

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[317] Section 4.3.1 of this chapter will deal with live sampling in more detail.
[318] Croft 2007.
[319] Croft 2007, 62.
[320] Sakonda 2001.
[321] See Appendix IV, Figure A5.

trigger prevention and overwrite are additions to help adjusting the behaviour of the granulator when the process is controlled by audio analysis.

The design of the second granulation module[322] allows intensional accumulation and retrieval of material. Rather than replacing the buffer content, the recording sections are amended. An unlimited amount of sections can be recorded totalling a maximum of 10 min. Each section can be refocused and granulated in the techniques described above and mixing the sections is currently not possible.

The pitch module[323] is allowing to cross-fade (parameter: swRingGizmo) between a ring modulator (parameter: carrier frequency) and a FFT-based real-time transposer (gizmo~, parameter: pitch). The high-pass filter is implemented to help to control feedback issues.

The fffb module[324] uses a fast fixed filter bank (fffb~, n-number of resonating filters). This module uses 6 filter bands and allows frequency, Q and gain settings. Experiments had shown that the filter produces interesting ‘bubbly’ artifacts and glitches when extreme frequency, Q and gain values are used. This had sparked the idea that each filter bank to be enveloped (parameter: fffbRamp) so that the filter is only audible for a specified time. The frequency is set for each band sequentially and the range is controlled by two combined controllers (fffbPitch and fffbTranspose). The filter changes can be time limited (fffbSpeedLimit). The process required the implementation of several amplitude limiting procedures to avoid sudden and ear-splitting feedback in extreme frequencies.

The Partial Synth module[325] uses frequency analysis on the module signal input. The raw frequency and amplitude data of the detected partials is fed into the resonators~ filter by CNMAT which filters white noise (or a separate audio signal) with these extreme filters. In this manner this module uses an approach to resynthesise the analysed signal.

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[322] See Appendix IV, Figure A6.
[323] See Appendix IV, Figure A7.
[324] See Appendix IV, Figure A8.
[325] See Appendix IV, Figure A9. resonators~ by CNMAT http://cnmat.berkeley.edu/patch/4019)

4.1.3.3. The Schematic of the *piano*+

The schemata of the overall software design (as used in the years 2010-2012) is illustrated in Figure 4.3. The grey components reflect the general structure of the performance system as described in Chapter 2[326] while the black printed module descriptions show the implemented modules for the processes and control structure (see Appendix IV – *piano*+ (version 2011), Figures A1-A16 for screenshots of the Max patches and photos of the setup). The implemented structure reveals an emphasis on the sonic potential of the instrument, with the prime concern of enabling different timbres while retaining a haptic[327], tactile, and heuristic relationship between the acoustic playing and the electronic manipulation. The alternative approach – aiming to implement generative algorithms for functional accompaniment and augmentation of solo performance to replace fellow players – has musical interest and validity, especially when considered as poles of a continuum which allows any combination of the two.

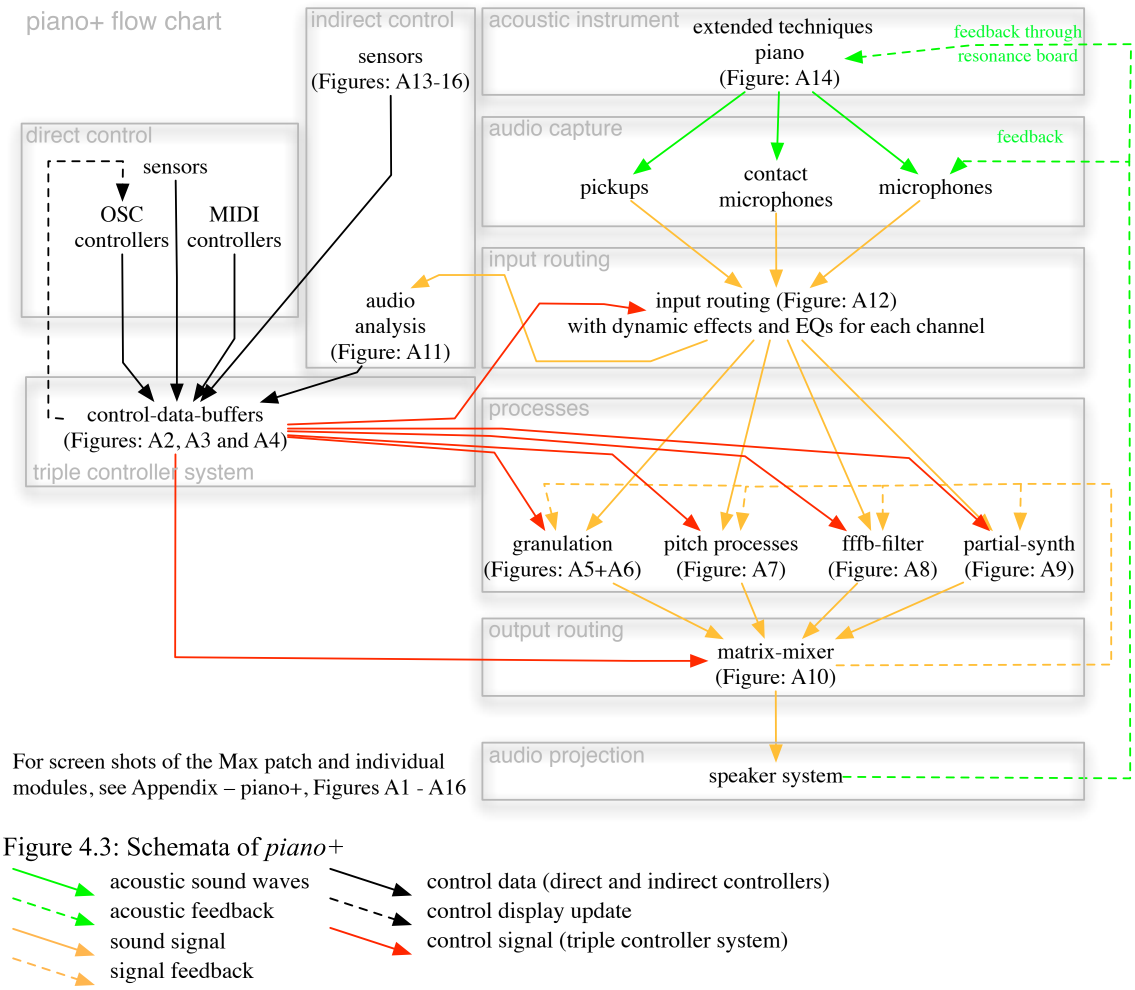

Figure 4.3: Schemata of *piano*+

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327 The haptic aspect is only in relation of the acoustic instrument here, which can however affect the electroacoustic processes.

This continuum from the purely instrumental, where modifications, however subtle, are in direct control of the performer, and the completely generative, contributing an autonomous element in the performance that links all controls to data-streams from algorithms. In between, but closer to the instrumental, indirect controls derived from performance activity (e.g. sensors, controllers) and audio analysis[328] would affect the parameters set by direct controls. Generative approaches could be added to these processes, for example influencing the effect processes over time according to algorithmic/analytical calculations. Closer to the generative still, we would find approaches which use generative algorithms[329] combined with direct and indirect controls from performance activity (sensors, controllers) and sonic results (audio analysis, machine listening).

4.2. Sources of Controls for Parameter Mapping: Direct and Indirect Control

As mentioned above, the required controls can be classified into two different categories: direct and indirect. The drawback of direct control is that the performer has to engage in operative gestures which can interfere with the performance activity. The dichotomy of intentional changes to the system and interruption to the musical flow could only be resolved by using an assistant. This is common practice in compositions combining acoustic instruments and live electronics[330] as well as in approaches in which the computer recycles audio feeds from acoustic players[331]. The results of performances yield some musical interest, but nevertheless reveal a fundamental dilemma about electronic real-time processes that are based on material captured from the live acoustic performance as opposed to systems involving synthesis and pre-sampled material. In the absence of a predetermined structure outlining the essence of the musical content or characteristics, the performer operating the electronics has no distinct musical identity. The apparent endless electroacoustic possibilities to manipulate the captured live

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[328] Emmerson 2007, 138.

[329] Bown and Lexer 2006. See Section 4.6 for more detail.

[330] E.g. Harvey: *Bird Concerto with Pianosong* (2001).

[331] Solar Winds by Lawrence Casserley and Evan Parker (http://www.touchmusic.org.uk/catalogue/to35_evan_parker_lawrence_cass.html), Frédéric Blondy and Diemo Schwarz, Concert on the 18.11.2011 at The Warehouse, Waterloo, London. This has also been investigated by the author using the *piano+* system on occasions when no piano was available: e.g. Seymour Wright as part of the Foldback Festival, 295 Haggerston Rd, London E8 on the 05.08.2006, with Durrant, Drew, Lely and Mattin Shunt Concert: Man & Machine 14.06.2007.

material has can nevertheless rarely avoid references to the source. The electroacoustic material reworks musical ideas of the acoustic player but retains melodic and motivic contours, rhythmic arrangement and the spectral distribution of the harmonics in the sound. The electroacoustic part can fill the gaps the acoustic performer leaves, but the musical material will hardly develop true autonomy in content to take lead during the performance. Also the acoustic player is in a peculiar situation when their material persists beyond their contribution. They are aware that their sounds form the basis of the processes and might be able to develop strategies to ensure specific material appears in the electroacoustic textures, but they are powerless to remove material from the electroacoustic process.

4.2.1. Indirect Control Through Audio Analysis

Audio analysis tools are intrinsic to the augmentation of the acoustic piano. Tools measuring amplitude[332], pitch[333] and significant changes in the frequency spectrum[334] or registering the percussive attack of a new sound, are a gateway to creating music/sound aware processes. The piano is in general well-suited to audio analysis: notes played conventionally have a clear attack, pitches are clearly distinguishable and stable, and it can produce a wide range of tones and timbres. There is the potential to design processes that, for example, only happen if a sound louder than a specified value, a particular note, or a new onset (attack) is detected. Precise analysis would require monophonic lines, as the process cannot distinguish polyphonic voices. The analysis treats the input as if it is monophonic: estimating one fundamental for the entire frequency spectrum. Musical and aesthetic rules have to be encoded and implemented. The machine is neither listening nor capable of making decisions equivalent to those of a performer, unless modes of listening and responding were modelled[335] through appropriate algorithms and implemented by the programmer, as simple or sophisticated as the rules might be.

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[332] Available in Max/MSP: peakamp~ enables amplitude readings of the audio.

[333] Available for Max/MSP: fiddle~ analyses audio spectrum to estimate the fundamental of a note (http://crca.ucsd.edu/~tapel/software.html), several other algorithms are available within the Max community (e.g. sigmund~,pitch~, analyzer~), as well as from the IRCAM real-time musical interaction library (http://forumnet.ircam.fr/704.html?&L=1)

[334] Available for Max/MSP: bonk~ onset detection (http://crca.ucsd.edu/~tapel/software.html)

[335] GenJam by John Al Biles (Miranda and Biles 2007, 137-169), Voyager by George E. Lewis (Lewis 2000).

4.2.2. Indirect Control Through Sensor Readings

Experimentation with sensors is another important part of this research[336], as a means to derive control data from musical gestures and to enable control without needing to operate the laptop or MIDI controllers placed near the piano manually. Pressure sensors[337] can be placed unobtrusively at various places on the frame close to the area of activity, making them easily accessible to control processes directly. When attached to objects or tools (e.g. beaters) used to play inside the piano, the sensors can capture data about the physical intensity of activity (i.e. strength of grip) for indirect control. While this method has great potential, the required cables for the sensors can make their use problematic. Affordable practical wireless solutions have not been available. Infrared (IR) distance sensors[338] have the advantage of observing movement in the air but can become unreliable in certain light conditions. Taking inspiration from Waisvisz's *The Hands*[339] or the commercial *P5 Glove*[340], the placement of sensors on the hand (e.g. bend or pressure sensors) give flexible control opportunities, but restricted performance activities on the piano, even when reduced designs used only one IR distance sensor at the wrist and one bend[341] and pressure sensor on the index finger[342].

Another successful approach uses video colour tracking. A brightly coloured velcro[343] ring at the thumb allows flexible two dimensional control which has some advantages to the IR sensors. The ring being easily visible for the camera, or hidden by moving the thumb below the palm of the hand, enables a more intentional binary level of control, whether the data gathered is being used or not[344]. More complex routing options allow the tracked movement to be used to query a picture for colour values[345], which are used

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[336] First experiments were using the Pocket Electronic by Doepfer (http://doepfer.de), the Gluion (Barefoot) (http://glui.de) is the current digitising board for the sensors used in my setup.

[337] Interlink Electronics FSRTM 400 Force Sensing Resistor.

[338] Infrared Proximity Sensor Short Range - Sharp GP2D120XJ00F.

[339] Waisvisz 1984, 1989, 2005 http://www.crackle.org/TheHands.htm.

[340] Vrealities http://www.vrealities.com/P5.html.

[341] Flex sensor 2.2" by Spectra Symbol.

[342] Experiments conducted, see Appendix V – *piano+* (version 2005) Figure B9.

[343] The loop side of a velcro strip shows a very even colour throughout, as it does not reflect light or casts shadows.

[344] Videoed example Interlace 27.03.2004.

[345] This system was developed for the development of Emmanuelle Waeckerles VINST project. http://sebastianlexer.eu/projects/installations/ .

to determine parameters of processes[346]. A more complex system of a three-dimensional colour-mediated control structures was developed, consisting of colour-mediated audio analysis data[347] and a three-dimensional 'data-space', and applied in concerts.

Such video based gesture analysis implementations, however, proved too impractical and CPU intensive to form a viable performance system[348] and are therefore not discussed in further detail within this thesis as they have not been used in performances.

The current setup of the *piano+* uses the *Gluion* board to digitise the data from a variety of sensors. Two tilt sensing acceleration sensors[349], the first attached to a small metal ruler to enhance the perception and control of the tilting gestures with an addition touch sensing strip[350]. The second is mounted on a separate breakout circuit combined with a gyros sensor[351] and a pressure sensor. Both devices[352] are intended to be held and used with the hand or rested in appropriate angle on the instrument. Two IR short range sensors mounted on a small breakout circuit are usually placed inside the piano to allow sensing the distance of the hands, arms, or even head placed above the sensors.

4.3. Comparative Case Studies

4.3.1. Case Study: Live Sampling

Live sampling techniques have had a significant role within the development of the *piano+*. The following description will show that from the initial attempts to alter fundamental characteristics of the piano using technology, the current approach to programming the performance system was emerging, rather than designed to realise

[346] See Appendix V – *piano+* (version 2005): Figure B10 for an example of colour based mapping. Developed in the years 2004-2005 and preceding official launch of Timothy Place's Hipno plugins (NAMM show 2007) which use a similar strategy to morph between saved preset setting (http://electrotap.com/blog/category/Hipno). The plugins were available between 2007 and 2009 from cycling74.com but discontinued.

[347] See Appendix V – *piano+* (version 2005): Figure B11. Audio examples 2005-06-01_dataGloveTest_ex1, 2 and 3.

[348] Although a very effective form of control, the development was put on hold after using it for the performances at the Sonic Arts Network Expo 966 (18.06.2005) in a trio with Tim Blackwell and Michael Young and during a solo set at University of East Anglia (10.10.2005). The system required two computers and was therefore very impractical. See Appendix V – *piano+* (version 2005) for screenshots of the 'data-spaces' (Figure B12).

[349] Triple axis accelerometer ADXL335 by Analog Devices.

[350] SoftPot by SpectraSymbol.

[351] Triple-Axis Digital-Output Gyro ITG-3200 by InvenSense.

[352] See Appendix IV – *piano+* (version 2011): Figure A15.

preplanned theoretical considerations[353]. Brief descriptions of the technological realisation of this process are followed by an outline of musical potential and a practical evaluation.

The initial research into elongating piano textures was through looping single notes, chords and sounds eliminating their attack phase by superimposing amplitude envelopes. In a conventional Digital Audio Workstation[354] this could be achieved through editing: Firstly, a section of a suitable recording of a piano note or chord is trimmed to an appropriate length (e.g. five seconds), cutting away the initial attack of the sound in order to select the more homogeneous decay phase of the note. Secondly, applying long fades (e.g. two seconds) to eliminate the sudden start effectively. One can make as gradual a fade-in of the sound as the natural decay. The resulting sound, appearing and disappearing in smooth shapes could be looped, overlaid and staggered with several other loops of the same edited sample to generate a continuous endless note.[355]

Using audio analysis tools it is possible to automate the enveloping and looping process in real-time on sounds captured during live performance. For example, onset detection would be occurring simultaneously during the performance. Timings of onsets in relation to the start of the recording enable an automated audio segmentation so that every note played by the performer is time-indexed accurately.

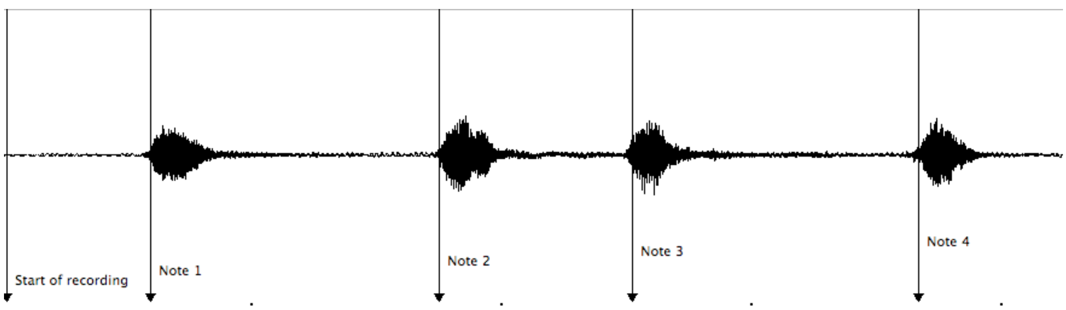

Figure 4.4: Automated time-indexing of sampled material:
0 ms - start recording
1180 ms - first note
3500 ms - second note
5000 ms - third note
...

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[353] An approach which appears more common within commercial software development, which plans software development in line with proposed and imagined user applications in mind.

[354] DAW. e.g. Pro Tools, Logic, Digital Performer etc.

[355] This method is very similar to the standard approach for granulation (Roads 1996, 2004), although granulation resorts to much smaller loop sections (ca. 80 - 250 ms).

Using appropriate playback engines, it is then possible to play each note separately in the same way as one can choose to play individual tracks of a CD. In order to create a suitable yet simple approach to turn this into a real-time process (that would not require any operative tasks to select the region and to apply the fades), one assumes that the first note starts at the indexed time measurement and stops at the start time for the second (Figure 4.4). The envelope shape and length applied to the playback are set to the duration calculated ([start second note] - [start first note] = 3500 - 1180 = 2320 ms) and re-trigger timings are set appropriately in relation to the duration to generate the continuous drone.

This live sampling approach yields much potential to generate new textures and material derived from the performer: the ability to create drones from single notes, ‘freezing’ what has been played, generating new material by reordering the notes[356], and to generate chords combining different notes[357]. Manipulation of the playback speed allows transpositions, extending the harmonic possibilities during playback of the captured material[358].

This approach has significant implications for a possible performance strategy. Firstly, the recorded material ought to have suitable spacing between the events to allow the automatic creation of the drone textures and to ensure reliability of the onset detection. Secondly, the decision to apply this live sampling process has to be made in anticipation of its suitability, the decision cannot be made recursively.

In order to enable recursive decisions, the entire performance could be recorded, so that at any point in time previous material could be selected. But this only highlights the next problem: how can suitable material be selected from the accumulated samples without pre-listening? Which material, perceived by the performer as belonging to one section, resulted from intentional decisions to create relationships between sounds, and which was realised afterwards so that some of the sampled material could serve to accompany or juxtapose the current moment? During a live performance there simply isn’t the scope for the performer to tag sampled material and, although randomised

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[356] Playback of segments without removing the attack phase or looping.

[357] Simultaneous playback of several segments with or without attacks or looping.

[358] Audio Example 2007-04-20_liveSamplingVariation.aif : Working with the transpositions of a limited number of samples.

selections can be interesting at times, they might also feel unsatisfactory and disturb the intended musical flow. While musical idioms can be modelled through generative and algorithmic means, the interest for improvised scenarios is to establish contingent systems that have algorithmic means to make meaningful choices from a selection of samples. A system using audio descriptors, i.e. data sets generated from various audio analysis tools, would be possible adaptations to the live sampling in order to allow retrieval of more specific material[359].

The research for approaches to facilitating a meaningful tagging and retrieval of accumulated samples has resulted in several practical experiments exploring different basic techniques. These include storing the data from various analysis tools for each segment of the sample, to allow internal reordering or retrieving samples according to, for example, specific pitch values. Although some of these experiments were satisfying[360].

Despite some overall successful and interesting results, especially in more controlled settings and combined with Bown's CTRNN neural networks [361], the musical results continued to lack a practicality and flexibility required for the musical demands encountered in free improvisation. The results is noticeably misplaced when the audio analysis takes data from other players, as their sound bleeds into the microphones, or recalled sample segments contain distinctly audible material from them, as the capturing process was not isolated enough. Total isolation of the audio is not possible, even when using contact microphones[362] as, despite largely improved separation results, the large resonating body of the piano still captures the sounds of other players. Contact microphones also reduce the extended acoustic techniques being captured. This highlights the fact that strategies investigating live sampling are more challenging in concert situations than in solo sessions in a studio environment. Segmentation might

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[359] Available tools are soundspotter (Casey 2002), Frankenstein (Casal 2007) and catArt (Schwarz 2006). These are discussed in some more detailed in Chapter 6.2.1.

[360] Audio example 2007-04-20_liveSamplingVariation2.aif . Loudness was mapped to retrieve sample excerpts automatically tagged according to the centroid analysed and stored.

[361] Bown 2006. Extensive experimentation was made in collaboration with Oliver Bown. The research output was presented at the evoMUSART 2006 in Budapest, both in a paper session and associated concert at the ArtPool in Budapest.

[362] For example C-ducers http://www.c-ducer.com/

occur on onsets of other instruments or within a successful segmentation of a piano note, other instruments could be audible[363].

A project with Dario Bernal Villegas on drums was set up in order to use the unavoidable bleeding of other musicians sound as a feature rather than a problem, and deliberately allow the drums to participate in the segmentation and sampling processes. As the two audio excerpts 2007-10-07_DBV+SL@TCM_ex1 and 2007-10-07_DBV+SL@TCM_ex2 show, the percussive nature of the entire improvisation utilises this approach favourably. The segments played back are short or contain rhythmic patterns rather than melodic fragments creating ambiguities between the sampled and the real. The fast succession of triggers appears appropriate for the sampled material to work within the overall structure. The methods used for retrieval of sampled material were simple amplitude and frequency dependencies, which might not be perceivable in the exact causalities between live sound and retrieved sample, but nevertheless contribute to the overall musical coherence of the performance (Audio example 2007-10-07_DBV+SL@TCM_ex3).

It became clear that to overcome the lack of sophistication, a fundamental rethink of conceptual and musical possibilities was necessary. One possibility is to broaden the compositional strategies to ensure appropriate material for sampling[364], or generate the sonic environment to use prerecorded and edited samples. Another would be to enhance the computer analysis of the performance to increase the precision of data derived in combination with advanced approaches for data retrieval and sample selection as developed by Schwarz and Casal[365].

The recordings with Villegas were the last occasion my live sampling technique was used. The more sophisticated algorithms for retrieval methods require considerable processing power which defied the practicality of the system. Therefore this path of research was abandoned and performances over the past four years focused on granulation, which as the following section will show has particular idiosyncratic advantages suiting the concept of the *piano+*.

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[363] The musical implication of this will be discussed in Chapter 5. Here it should only be noted that this issue of bleeding has never been regarded as too much of a fault, but it should be acknowledged that it resulted in situations which felt unsatisfactory as one's own playing, sense of direction and structure seemed compromised by the others.

[364] For example as done by Thomas Gardener for Lipsync (2005) and by Javier Garavaglia for Ninth (2002).

[365] Schwarz 2006, Casal 2007.

4.3.2 Case Study: Granulation

Investigations into the possibilities of granulation experimented with the well-established possibilities of manipulating playback speed without affecting pitch or transposing audio without altering duration[366]. Granular synthesis techniques theorised by Xenakis[367] and Roads[368] were explored as well, but the concepts of clouds and synthesis of textures from fragmented and dislocated grains has not been of particular personal interest. However, the possibility of slowing down and freezing sounds and creating textures from reverse playback were immediately seen as a suitable means to overcome the idiosyncrasies of the piano while maintaining its characteristics. The granulation technique resembles the basic approach of the live sampling technique used for drone creation as multiple instances of an audio segment are looped simultaneously. The playback of grains, using tiny segments of audio, are organised out of phase to create the illusion that the sound is continuous. Grain sizes of 80 ms are sufficient to create convincing results retaining acoustic resemblance to the original[369]. As the sample position and pitch of the playback can be independently controlled, the performer has the possibility of 'tuning' into suitable fragments using a sensor or any other direct or indirect controller considered appropriate, e.g. the analysis data of the loudness of the current acoustic sound. The captured material can be reshaped entirely by controlling three parameters: position, pitch and volume of the playback.

Granulation was therefore considered a more satisfactory and practical solution for live performance situations allowing the eventualities of musical situations: 'inappropriate'[370] material can easily be changed by 'tuning' the playback position to something more suitable, adapting volume to blend into the current proceedings or generate counterpoint to the acoustic instrument. But most importantly, the process

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[366] The first Granulation patches used Granular2.5 by Sakonda (2000). Further granulators were built by me using Nathan Wolek's Granular Tool Kit (http://www.lowkeydigitalstudio.com/2007/03/granular-toolkit-v1-49/) taking advantage of the grain.phasor~ object, but eventually I have returned to a granulator modeled on Sakonda's MSP programming approach.

[367] Xenakis 1992: 237: Grains described as Sonotrons.

[368] Roads 2004

[369] One problem of granulation is that due to the overlay the resulting signals shows considerable phasing artefacts. This has in itself not been considered too much an issue within this project, especially within live situations. Alternative methods would involve phase-vocoding and other spectral synthesis techniques which are able to use the spectral contours of the captured original in real time. Although the underlying technology differs significant from granular synthesis, the application and considerations described here would be fully transferable.

[370] 'Inappropriate' is situational, i.e. a dislike of the sound itself, avoidance of fragments of sound attacks which result in more noisy result than during sustained or decaying textures.

allows control within a field of possible treatments. All parameters can be adjusted in a continuum, whether the sample is played in real-time, faster and slower, or the playback is frozen to a fixed position. The same applies to volume and pitch, either to create transpositions (all grains are tuned to the same value) or to produce polyphonic textures (grains are set to different values).

Next to the interesting sonic qualities of granulation the suitability of the process depends on the integration of the necessary controls. Direct control for the recording would be most reliable in terms of ensuring the capturing of the intended material. A tilt sensor to set the granulation position by a left/right rotation and volume control with forward/backward rotation would give overall gestural control. However, in practice it has also proven beneficial to have a way to limit the granulated material to a smaller selection, thus setting a minimum and maximum range to the sensor movement. Being able to influence the area of the buffer (recording) can adapt the precision of the movement through the recorded material or enable calibration of the sensor data to the physical gesture made. Given such adjustable and precise controls, granulation can be used for longer sections: adjustment of range enables the musician to focus into a certain section of material, while the rotation controls the actual playback position within this selections. A process module has been implemented allowing an arbitrary number of sections totalling up to ten minutes of recording time[371].

When an indirect control, such as onset detection, is used to trigger the recording with a significant event[372], shorter buffer times are more appropriate and settings allow us to grab these events immediately for processing to sustain or produce irregular repetitions. The repetitions might be perceived as an ordinary delay line. But the result differs as the timing between events varies due to randomised modulation of the set playback position. For the first scenario it is sufficient to map the onset detection to trigger the recording. No other operational tasks are required as the position of the granulator can be set to a constant value in order to freeze a sound. The granulated sound can be enriched by setting the position modulation to a random factor (i.e. within a range of 1% of the set position). Any new onset detected retriggers the recording and exchanges the

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[371] This granulation module with a 10 min recording buffer is not separately displayed in the flow chart of figure 4.3.

[372] Significant has to be understood as a significant change in the spectral composite of the sound not of aesthetic significance.

granulated material. A deliberate avoidance of significant attacks enables us to engage in counterpoint with the currently played material (audio example *Rapprochement* and *Opposition*). The process is closely linked to the acoustic activity of the performer, who can provoke changes and also attempt to keep responses by adapting her/his play. Practical application has shown how diverse the musical results can be although the parameters were not changed or adapted in any way. The process can be integrated to the performance activity in more complex ways by mapping indirect controls to more parameters (e.g. loudness to control granulation position). The increased complexity in control remains closely related to the acoustic activity of the performer, who is controlling all aspects of the process by musical gestures alone.

Despite the possible musical diversity, the last approach cannot be applied universally. Each approach has unique and significant musical potential. In other words: the two described methods form somewhat different poles within the field of possible "horizontal processes"[373] of the audio modulation. When further mappings are added, different approaches to the musical activity are possible. Considering the general discussion on parameter mapping in previous chapters, and considering the extensive research output available on this topic, the relation between process, its control structure and the resulting musical output is hardly surprising. But what appears to be absent from existing research are propositions of how it is possible to gradually change the paradigm of control: i.e., enabling a gradual focus on either control method that avoids binary decisions. Plotting the possibilities on a field of possibilities[374] shows that it ought to be possible to find any mixture between different methods. The search is for implementations that allow intuitively controllable processes within a true continuum while keeping operational tasks to a minimum. The possibility to change paradigm of controls in such a manner would give a more natural feel to the controls of processes matching qualities of acoustic instruments.

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[373] See Chapter 2 (p. 51) for definition.

[374] Equipping the 'inner space' of the process.

4.4. Parameter Space – the Potential of Triple Controller System

The *piano+* patches have had various approaches to change controllers, implemented and tested over time. In many respects the most challenging work has been to develop a suitable approach. In hindsight it feels that choosing suitable effects processes was easy, while each control implementation affected performance practice significantly[375]. For example, an early version used drop down menus to change parameter control (i.e. from onset detection to manual control). This approach proved utterly impractical, as changes relied on operational activity on the laptop, requiring several clicks. By the time new selections had been made the musical flow was disturbed. In concert situations changes were therefore avoided, but one was left with the impression that the performance fell short of its potential as a change might have made the electroacoustic processes more appropriate to the situation and musically interesting.

The realisation of a dynamically changeable system, as proposed in the previous section, requires a sophisticated convergent control implementation, in which direct controls can merge with indirect controls by changing the weighting between the two control methods. In the scenarios given above, for example, this would mean that the manual trigger for granulation merges with the triggers from the onset detection: a sensor controlling the position between a set minimum and maximum value could be gradually replaced by values from the amplitude analysis.

To enable the combination of different controllers for parameter control (convergent mapping) all controller data streams are scaled to a range between 0.0 and 1.0, irrespective of their initial interfacing data[376], data type and rate[377]. These are stored in audio buffers at discreet sample indexes. A direct MIDI controller (value range 0-127, received with associated controller number and MIDI channel) is converted into a <index> <value> list (e.g. ‘f35 0.3’), where the index is a symbol combining an

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[375] See Appendix IV – *piano+* (version 2011) and Appendix V – *piano+* (version 2005).

[376] MIDI, continuous sensor readings from serial ports or network transfers, audio analysis data.

[377] The development included versions using Max abstractions using send/receives and route, Jitter, FTM (IRCAM) but these versions suffered from some sluggish response dependent on the overall CPU usage. The final version transforming all controllers into the signal rate (using buffer~, peek~, poke~, index~) has helped to overcome these shortcomings and made the overall system much more responsive and accurate. The difference was clearly felt and is thought of as potentially the turning point from a system which was interesting to use and for which one could see much potential, into one which brought everything together and enabled a real progress in the actual performance practice.

abbreviation for the controller device[378] and controller number, and the value is the scaled value. For the example 'f35 0.3' the value '0.3' would be written for sample index '35' inside the audio-buffer 'f'[379] (Figure 4.5).

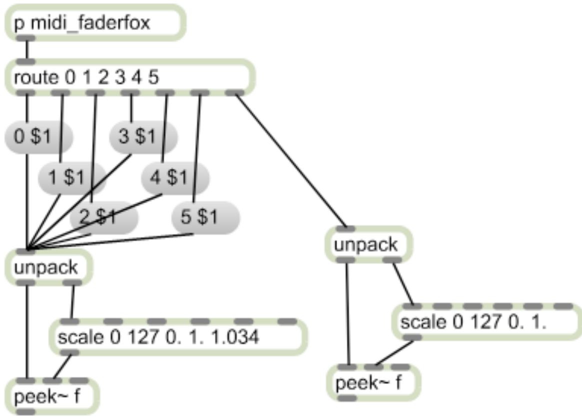

Figure 4.5: Scaling and storing direct controller values into the audio based control system

As an example for an indirect controller (Figure 4.6), the value derived from continuous controller streams through audio analysis (e.g. peak amplitude) would be scaled and assigned to the index 'a0. Therefore the value received from the amplitude reading would be stored in audio-buffer 'a' at sample index '0'.

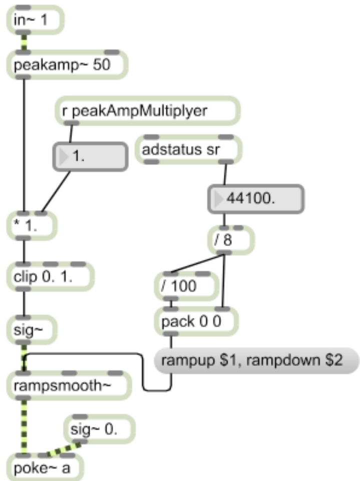

Figure 4.6: Scaling and storing indirect controller values into the audio based control system (e.g. 'a0')

The current system uses command line style definitions to set up to three controllers per parameter. The first is can be considered as the main controller while the other two influence the range of the first. For example (Figure 4.7), 'a0 f35 f36 2000. 5000.' would use the amplitude reading 'a0' to set parameter between 3000 and 5000 ms. The MIDI controllers 'f35' and 'f36' could adapt the given minimum and maximum settings

[378] I.e. f0 - f65 for the controllers available from the Faderfox MIDI controller, a0 - a15 for data from audio analysis, or g0 - g76 for the sensor readings from the gluion digitising board.

[379] 'f' has been arbitrarily chosen to index MIDI data from a Faderfox LV2 MIDI controller.

by 0 - 100%. f35 would enable to change the minimum between 3000 (R[min]) and 5000 (R[max]), f36 the maximum.

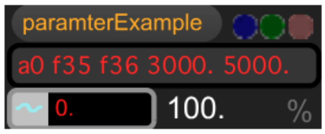

Figure 4.7: Parameter control module with command line style triple controller definition.

Mathematically the three controllers are combined within their range of 0. and 1.:

$$V(c) = (v[a0] * (v[f36] - v[f35])) + v[f35]$$

This value is then scaled according to the range defined by the numeric range:

$$V(p) = (V(c) * (R[min] - R[max])) + R[min]$$

Setting controller f35 to its minimum (f35 = 0.) and f36 to its maximum (f36 = 1.), the amplitude reading (a0) has maximum effect (values between 3000 and 5000) on the process. As the range is controllable by these two controllers it is possible to regulate how much the process is affected by the amplitude reading. This system has the scope to make a0 inactive and set the process to a fixed value in the case both controllers are set to the same value (f35 = f36). The range of action can be reversed by setting the maximum to a lower value than the minimum (f35 > f36).

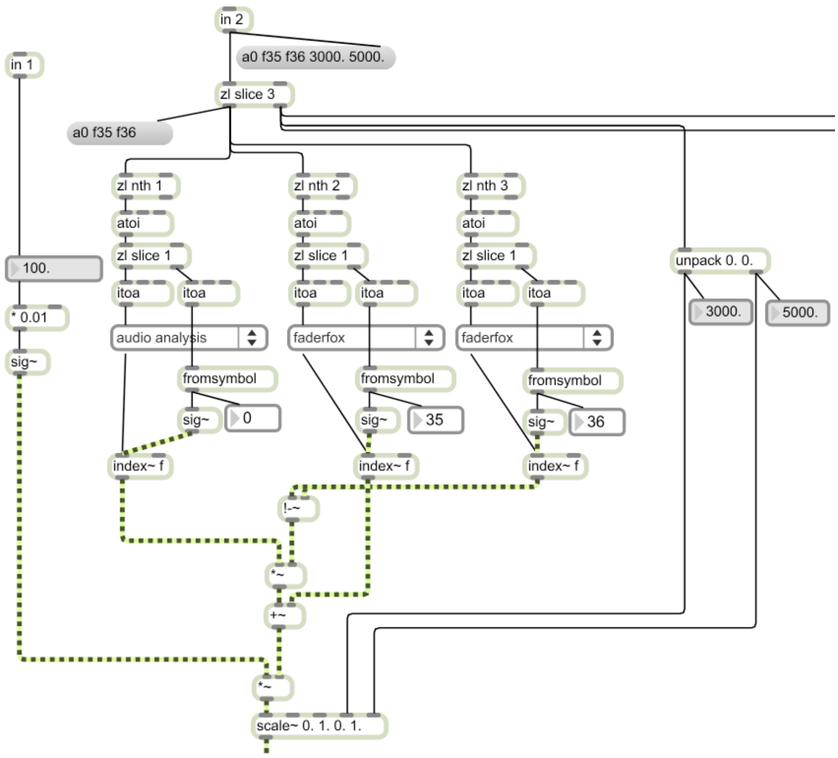

Figure 4.8: Conversion of the command style controller definition into the actual parameter value

To exemplify these relationships between the three controllers, a selection of scenarios (Figures 4.9 - 4.12) are described and a graphical illustration of its possibilities is given below.

In the first scenario two direct controllers are used to control the range of a control stream from the audio analysis as described above. Figure 4.9 shows this standard scenario where the data stream (C1) from the amplitude reading (a0) sets the parameter value within the range set by C2 and C3 (e.g. MIDI f35, f36), inclusive reversing minimum and maximum values.

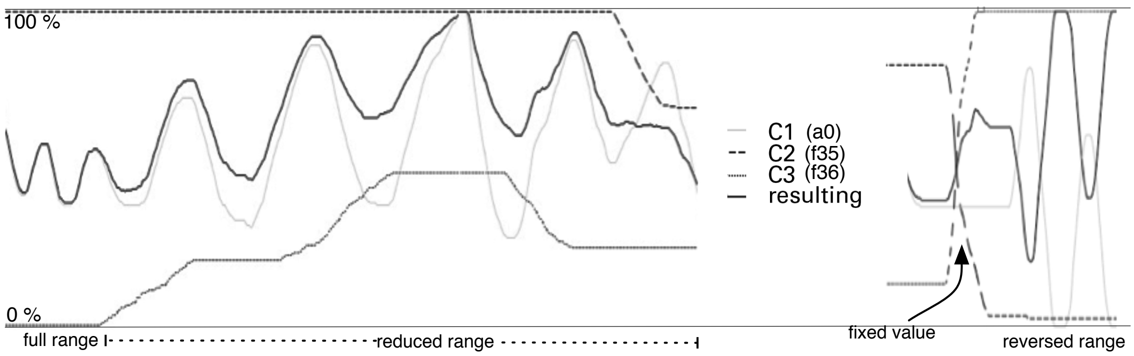

Figure 4.9: Standard set. The range is shown here in percentage as actual values would be scaled according to parameter ranges in the processes.

Figure 4.10 shows a different controller set where C2 (i.e. amplitude envelope) and C3 (i.e. sensor reading) are alternated by C1 (i.e. MIDI controller). In this scenario the MIDI controller allows to change focus on either data streams (C1 or C1). C1 set to the minimum value would focus on C3, as the maximum value would focus on C2.

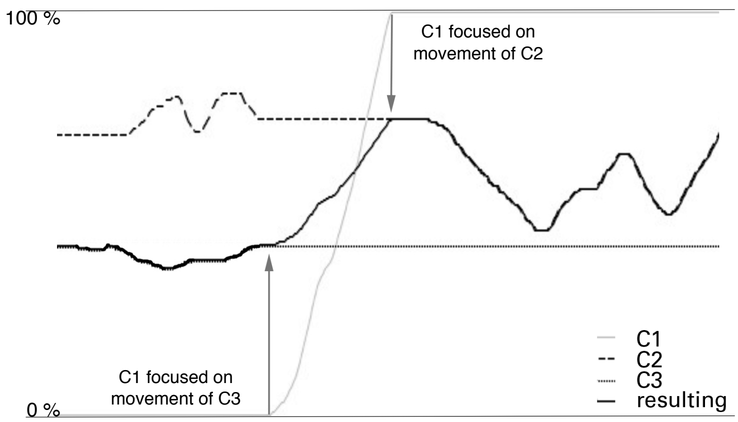

Figure 4.10: Changing focus between two continuous data streams (C2, C3) with C1.

Any other value of C1 would mix the controller streams is the resulting value would always be n% between the changing minimum and maximum values (Figure 4.11, i.e. C1 = 0.3 would take 30% of C3 and 70% of C2).

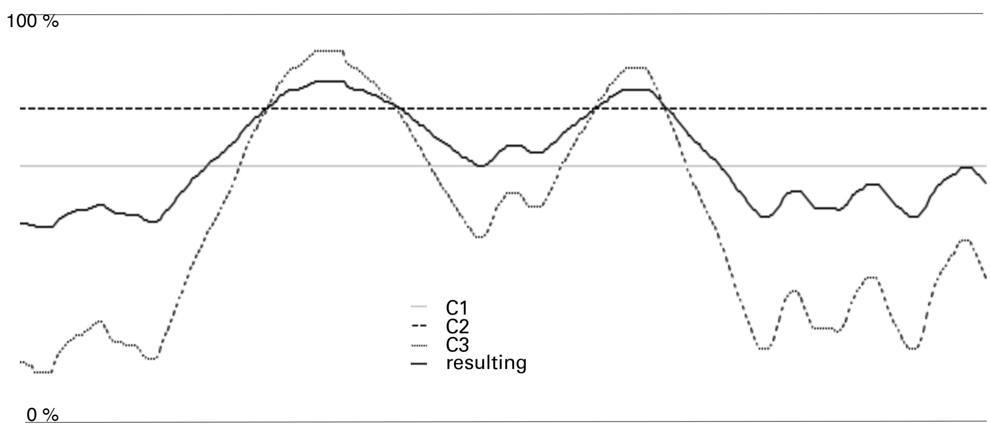

Figure 4.11: 'Mixing' two continuous data streams (C2, C3) with C1.

This triple controller set yields an astonishing practical use. With a minimum of operational tasks the behaviour of the process can be changed according to the musical situation and demand for intentional control. Focus on C2 would, for example, follow the amplitude reading of the performance activity. The performer (as well as fellow musicians) would in this case influence the parameter through their musical activity. Changing the focus on C3, allowing gestural control, would give independence of the current acoustic situation and enable the performer to have full control. It is considered here that the most powerful outcome of this setup is actually the mix between the two, so the performer has a degree of gestural control, while the acoustic situation has also its effect on the outcome.

The most extreme setup appears to gain contingent behaviour. In the case that all three controllers are set to continuous data streams (Figure 4.12) the influence through gestural and acoustic activity can be perceived but loses a clearly defined relationship. It hardly shows any accurately predictable results during performance as the interdependence between the three data streams is considerably complex.

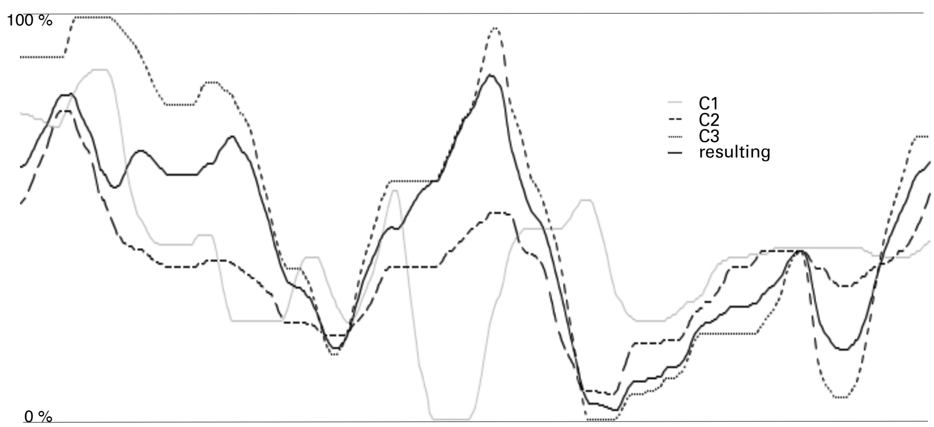

Figure 4.12: Contingent emergence.

Within their musical application the controls can be perceived as 'tendencies' and therefore have a heuristic character. The performer can explore these tendencies of control through musical gestures. Furthermore, this variety from loosely interconnected controller streams offers the possibility to use the same controllers in different combinations, to modulate several processes and effects simultaneously.

4.5. Other Implemented Processes

4.5.1 Ring Modulation and Pitch Shifting

The *piano+* also features a combined module of ring modulation and pitch shifting. Ring modulation has a long history within live electronic performances[380] and is commercially available since the early 1960s by Bode and Buchla. The distinct bell-like quality of the effect remains compelling, particularly when mixed with other processes, where either the acoustic sound is ring-modulated, but the granulated tail is not, or vice versa. The control required is minimal, only carrier frequency and volume, although a serially placed filter has been employed to reduce lower frequencies as the process introduces sidebands to the partials which can thicken the result unnecessarily and cause feedback problems. This process is pitch related, so an 'opposing' quality was selected to allow a different characteristic and to increase the parameter space. An FFT based transposer[381] was chosen allowing transpositions of -12 to 12 semitones. The parameters of the combined processes are assignable in the manner described in the previous section.

4.5.2. Filters

Filters are used in various forms in the processes designed for the *piano+*. Basic low- and high-pass filters are used to reduce problematic frequency areas and to treat the microphone inputs to reduce the chances of low feedback drones and reduce the sharpness of high pitched clicks which can occur in some processes. These filters have fixed settings that are only changed very occasionally and are therefore not considered as a performative tool here.

[380] I.e. Stockhausen's *Mantra* (1979).
[381] Based on gizmo~ in Max/MSP.

Experimentation with different filters has shown the possibility of (ab-)using a fast-fixed-filter-bank (fffb~ in Max5). Exaggerated values for frequency (including the Nyquist area, i.e. 1 - 44100Hz), Q and gain enable digital glitchy, 'bubbly', and 'airy' alienations of the incoming signal. This process has mainly been controlled by a pair of sensors (often IR distance sensors) to determine the frequency of the 8 filter bands, one to set a pitch, the other to transpose. Depending on the bandwidth Q and gain settings, the audio output can vary extremely in volume, particularly if the settings lie on one of the main partials of the sound. A rigorous limiting method was implemented to tame this process, as it had caused several sudden, dangerously loud moments during studio sessions and performances alike. Furthermore these extremely filtered frequency bands are only used for a short time (determinable and randomisable by a parameter). This filter allows the manipulation of the already quite dominant onset or to disrupt the otherwise smoother decay of the sounds and forms the most obvious digital transformation available in the setup, as they clearly signify electroacoustic treatments, rather than more subtle subversions of the acoustic sound.

The filter and pitch modules are regarded as 'processes on the vertical axis'[382], as these modulate the acoustic sound within the same amplitude shape. The fffb~ filter module has some perceivable impact on the 'horizontal axis'. The moment the individual filter bands open might be perceived as a distinct event[383]. Nevertheless, the process is always dependent on real-time input, even if it is near silence.

The fffb-filter implementation was initially developed to enhance the weaker partials in the piano spectrum. Audio analysis would set the pitch parameter while the performer would choose a transposition to allow the filter to tune into a specific harmonic of the note (under the assumption that the reading of the frequency was actually correct). A collaboration with the composer Michael Parsons exemplifies the intended sound quality best[384]. The problems with sudden bursts of noise and feedback described above, made it very difficult to employ this process effectively in practice. The process is either inaudible or vaguely noticeable, or within an instance ear-splitting noises can rapture through the proceedings. While limiting the audio signals allowed me to successfully

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382 See Chapter 2 for definition.

383 Audio example *Dazwischen, Defining Edges* minutes 0:50 - 2:00.

384 Electronic version of *Piano Piece 2002* by Michael Parson included on Data-DVD: file name: Parsons_PianoPiece2002.mp3

tame these outbursts, the overall quality remained generally unsatisfactory during improvisations.

"Study III"[385] and a solo performance at the UEA[386] document an attempt to utilise this process by implementing a more algorithmic method that combines the tuning of the filter bands with visual feedback. Possible notes would be suggested on the laptop screen, enabling a more intentional relationship with the filtering process. The performer can choose to play or avoid the suggested notes or notes of the respective harmonic series. While a more generative approach would have allowed me to develop this strain of experimentation further, especially within a more compositional approach, a sophisticated filter bank (resonators~[387]) was eventually chosen to filter white-noise according to the analysed partials in the acoustic signal. In this way the loudness of the partials can be more easily controlled to avoid extreme dynamic ranges described above. In practice it has shown that this process works well in combination with the pitch module, as they are sonically related. Furthermore this process results in the elongation of partials, it has therefore an enhanced affect on the 'horizontal axis' of the spectrum. After the values of the partials were established through audio analysis, the process continues to work independently.

4.6. Processes as a Space Outlined by the Vertical and Horizontal

These descriptions of electroacoustic processes, implemented in the current incarnation of the *piano+*, indicate the possibilities of working with the vertical and horizontal axes of the spectrum. This conceptual abstraction can be pushed further: each process has its strengths or focus within a particular area that can be placed within an imaginary space. It is not considered important here how the qualities of the processes are aligned to the directions in the space, however, as an example Figure 4.13 shows an amended version of the abstraction of sound properties (see Figure 2.1).

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[385] Performed at Goldsmiths 29.06.2005. Audio Recording included on Data-DVD file name: Study_III_(shifting_focus).mp3
[386] Solo performance at University of East Anglia, Music Department, on the 10.10.2005.
[387] Resonators~ is available for Max/MSP from CNMAT (http://cnmat.berkeley.edu/patch/4019).

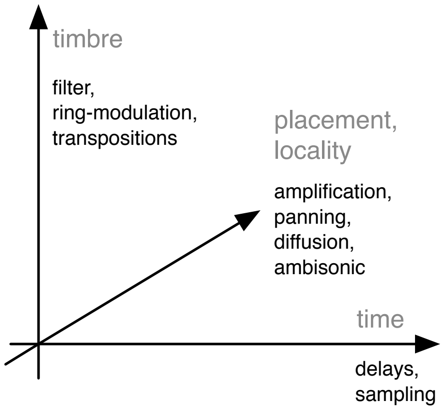

Figure 4.13: Abstraction of sound properties amended by a selection of suitable electroacoustic processes

When considering the qualities of the processes as parts, areas, poles, junks – part of the consistency – of the space, we can imagine that the parameters of the effects translate into a imaginary location, not necessarily as a coordinate, but as a descriptor. Parameter changes can then be considered as movement into a different part of the space whether this results from the modulation of the sound by a single process or a mixture of several serial or parallel effect processes.

For the performance activity itself, the technicalities of positioning the parameters of the sound ought to be irrelevant. Their control ought to be convenient without disturbing the musical flow. An awareness of the potential to relate to every sound within an imaginary parameter space will assist decision processes. To find the musically appropriate place one has the flexibility to move slightly more into one direction to enhance the processes on the vertical, i.e. to decrease the spectral density of the sound texture, then maybe to adapt the horizontal, so that textures are prolonged or repeated in order to move further away from the acoustic quality of the piano.

The described stage of the development the *piano+* was considered sufficiently flexible, and most importantly, showing contingent but influenceable qualities, so that further developments could be put on hold. Although in the period from 2004 to 2006 several other technical paths were explored and considered[388], some of which are briefly mentioned at relevant places within this thesis, they will not discussed in technical

388 E.g. colour-mediated parameter space, video control by colour tracking and gesture recognition using MnM (IRCAM), and algorithms such as Ollie Bown's CTRNN (Bown 2006), boids (http://www.red3d.com/cwr/boids/), CataRT by Diemo Schwarz (Schwarz 2006), the now discontinued multi-layer perceptron (MLP) by the CNMAT (http://archive.cnmat.berkeley.edu/MAX/neural-net.html) (all links were last accessed 21.07.2012).

detail. The development was ‘frozen‘ under practical considerations as well as some approaches would conflict with the aesthetic of the proposed performance practice.

It is thought to be a crucial aspect to consciously allow a prolonged period of practical exploration and application of its instrumental properties within the musical practice described in Chapter 3. Part of this decision has also been to limit the audio processes to a fixed selection. It became evident that the approach to develop an extended instrument requires time to learn the instrument. It is important to develop an understanding of its potential and to engage – as with the piano and the acoustic extended techniques – with the role the electroacoustic processes can play within an improvised performance approach. This decision has facilitated a concern with contingency within the electronics and highlighted the difficulty to induce meaningful musical responses of the system which yield a comparable element of surprise to the performer.

Nevertheless the design of the implemented control structure allows the user to ‘hook up’ the system to data streams supplied by generative approaches, where changes are occurring due to changes within sophisticated algorithms. Joint research and experiments have involved to combine the *piano+* with Bown’s CTRNN[389], a project which was continued within the LAM research group[390], and has “offer[ed] an opportunity to implement [...] contingent relationships between performer and electroacoustic process, generating micro structures that control electroacoustic processes in turn dependent on the performer’s activity.”[391] The means for parameter mapping were developed using my colour-mediated parameter spaces developed in Max/MSP/Jitter: After observation of the CTRNN behaviour represented as a movement inside a virtual space in correlation to the vector-based input (usually a combination of two indirect controller streams, e.g. xy-axis of tilt sensor) the user “could draw colour-coded regions into the 3-D space that he or she wishes to correlate to specific parameter settings of an instrument.”[392] The output of the colour-space are RGB colour values which are then separately usable as indirect controller streams, e.g. the value of the colour red could control the strength of ring-modulation etc.. The defined goal to find a solution never reached the stage that the

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[389] Bown and Lexer 2006.

[390] Prévost’s performance in Cafe Oto 2009 using the software of the *piano+* system in combination with Bown’s CTRNN algorithm. LAM workshop in Summer 2009.

[391] Bown and Lexer 2006, 6.

[392] Bown and Lexer 2006, 11. See Appendix V figure B12 for an example of a populated colour-space.

CTRNNs could be trained and evolved in real-time, thus technical realisation of heuristic algorithms were never implemented into this system.

The processes for the recordings of the realisation of Cage's *Electronic Music for Piano*[393] used completely randomised controls for the parameters. Colour coded star maps were loaded into a 2-D space and a randomised movement retrieved the proximity to the 'stars' as colour values being mapped to the parameters.

These activities have proven that the current implementation of the *piano+* yields much potential for further extension and research to include behavioural algorithms and machine listening strategies in the future. Within this thesis, however, the research into this field became marginalised, as the goal was set to research the instrumental qualities of the system, rather than developing a musical machine. It remains an important aspect that, despite the research into more flexible control structures and approaches, the processes are seen as empty vessels to be filled by the musical activity. In consequence each decision about process and its control retains direct implications on the musical potential. But it is proposed that these developments have narrowed the gap so that characteristics emerged not unlike the acoustic potential of physical instruments, as the interaction has become more flexible and requires significantly less intervention into the setup of the program (usually by operational tasks) during the performance. Some similarities can be found within the physical world: exchanging the means of sound activation, i.e. replacing the mallet with a bow. My observation how frequent Eddie Prévost manages to get pitches out of the bowed tam-tam which are in harmonic relationship to the pitches played by other players has let me wonder whether physical objects exposed to vibrations more easily be excited on sympathetic resonances within the material. Another example is the , slightly more understandable experience using the feedback through the pickups of the *piano+* which build more easily on frequencies of the sympathetic vibrations of the piano strings.

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[393] Tilbury and Lexer, *Lost Daylight*, Another Timbre, 2010. Mp3 version included on Data-DVD.

Chapter 5: The Theory of the Practice

The *piano+* system, outlined in the previous Chapter 4, is a technical realisation of an augmented instrument which is suited to be used in free improvised performances. The discussion of improvisation in Chapter 3 has shown that performance can be an investigative activity to explore the potential of the instrument and situation heuristically, allowing the “reflexive” journey to accumulate experiences and knowledge through the “actualisations” of ideas and unrealised “projected alternatives”. This chapter will introduce the metaphor of ‘equipping one’s inner space’, derived from Peter Sloterdijk's extensive philosophical excursion of spheres[394] which is related to aspects of the proposed performance practice. In this process, the division between personal and instrumental, acoustic and electronic, as well as temporary and total knowledge merges into a metaphorical abstraction: the potentiality space. The application of the same metaphor to delineate a variety of relevant theoretical aspects and issues concerning the performers approach and role, allows a different angle on the discussion of time perception, memory (human and technology) and activity. This facilitates the synthesis of the discussed philosophical and psychological theories to develop a description of a visionary performance practice: It utilises idiosyncratic technological features while retaining significant contingency which allows the performer to engage in a heuristic approach to performance.

The proposed model can serve to understand cognitive processes taken by the improvising performer as well as it becomes a useful tool for retrospective analysis of performances. It is also proposed that the creative processes required by the attentive audience member observing a freely improvised performance can also be approximated by this model. This, in turn, highlights the pluralistic nature of the comprehension of music, requiring individual responsibility in personal decisions and activities.

[394] Sloterdijk 1998 - 2004.

5.1. Models of Improvisatory Activity

The attempt to formulate a theoretical description of a performance practice initially presented an interesting dilemma: Firstly, it seemed that any theory of a performance practice is motivated by a reflective activity which describes and formulates underlying conditions detected in extensive performance experience that developed over a longer period of time. Secondly, it seems that one only has a reasonably valid starting point to envisage a performance practice after engaging in practical and theoretical research into the performance activity and instrument development. Both standpoints are unsuitable for a performance practice dealing with free improvisation, as the first is bound by references to experienced actualisations and the second is based on visionary ideas and prospects. In the course of conducting my theoretical and philosophical research, the value of an increase of awareness in the potentialities of ideas for a performer it became increasingly apparent. A conscious interest in plurality and contingencies can influence the nature of ideas and activity. The attempt to describe an activity within a loose system of possibilities, ideas, stimuli, influences, reactions, etc. appears futile as it either presents a crude reduction of the processes involved or comes across as a pretentious statement of omniscience. The following description illustrates the limitation: "in the case of a prolonged period of quiet textural sounds showing considerable complexities in harmonic construction, sudden bursts of harsh (noisy) and short sounds with sharp attacks, became a response to the inert complexities which initiated a change of the musical direction ...". This description is too literal to describe underlying concepts. Furthermore one would need to add a disclaimer that "none of the previously described implies that at the music could not have taken a completely different turn at any moment".

While the described dilemma caused conceptual and motivational difficulties at various stages throughout the thesis, the focus of it turned gradually towards a discussion of relevant aspects through underlying conceptions and approaches, rather than through analysis of actual sonic outcomes. This is seen as a shift from a retrospective and reflective discussion of a performance practice towards a projection of considerations which can inform novel performance practices engaging with new technologies.

5.1.1. "Arrow Model"

Part of the problem mentioned becomes also apparent in the 'arrow model' (see Figure 5.1). Its simplicity only allows us to describe the occurrence of a specific moment in time, marked as A. This moment can be the origin of an idea of possible direction towards B. The point x shows an influence which altered the direction of one's own actions to follow a newly formed idea (C). Point y describes an imaginary point where the external stimulus has been noticed but consciously ignored in relation to one's own actions.

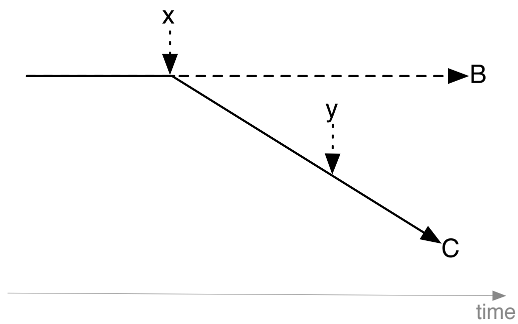

Figure 5.1: "Arrow Model"

This simple model has similarities to Pressing's loop model (see Chapter 3). It stresses the existence of an intentional direction of an idea in the performers' mind and acknowledges the willingness to adapt and adjust one's action in relation to external influences. In other words, there is a conversational aspect: the player formulates a musical idea but remains in close proximity to what is being contributed by others, according to which one's own idea is evaluated and adapted (open loop scenario). Or equally, it is possible that what was intended to be said becomes irrelevant to the musical discourse and is as a result discarded, while a new direction is pursued. The points x and y are both consciously perceived and evaluated in respect to one's own action.

Additionally, one has to note that the time span between a stimulus as influence and a reaction to it might be an unknown time-interval which might exceed what one would usually perceive as immediate. The moment of influence and its reaction might not even be obvious for observers at all. However, responding for the sake of an immediate response might merely appear as "sheep mentality"[395]. One can question whether such

[395] Dave Smith advised participants during rehearsals for the improvised parts in Cornelius Cardew's Great Learning to rethink one's contribution on different terms than simply reacting what is happening around them. (Grimma, Germany, 2000).

activity misses a real purpose and ought to be scrutinised as a superficially considered action.

5.1.2. "Flash Model"

As a conceivable refinement of the 'arrow model', the 'flash model' (see Figure 5.2) appears initially more appropriate for a more accurate abstraction of improvised performance. This model incorporates aspects of Sarath's improvisation model, in particular with respect to a distinction between "projected possibilities"[396] and the "alternative realised"[397]. It also acknowledges the absence of time perception when ideas are forming in the mind of the performer. Instead the performer might have an awareness of the duration and pace an idea requires to unfold.

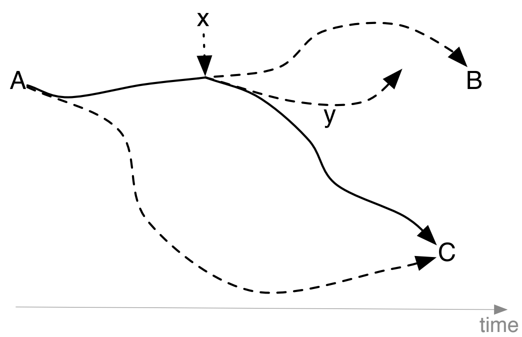

Figure 5.2: "Flash Model": projected possibilities represented in the 'flash model': while continuous and dashed lines originate in one moment of time, the continuous arrow represents the idea actually realised.

While the physical activity itself takes place within the lived experience of the moment – or in other words within 'real-time' – ideas contain an aspect of 'imploded' or 'compressed' time, which only unfolds within the process of actualisation. A possible parallel can be drawn to a phenomena which appears to occur in dreams. Within oneirology, the scientific approach to dream interpretation, the term "time dilation"[398] appears to describe such time compression. The actual existence of this phenomenon in dreams is debated. For this discussion it ought to suffice, that, on an empirical basis, creative ideas can appear instant although their realisation would require time. We also assume a condition here that an idea is not merely a 'pre-stored' thought which is recalled in an instant of time, but that it is an abstract outline of possibilities for the

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[396] Sarath 1996, 8.

[397] Sarath 1996, 10.

[398] While the term "time dilation" introduced by Einstein in 1907 (Reinhardt 2007) refers to phenomena within relativity theory, the term is also appearing in oneirology as possible explanation of the so called 'Alarm clock dreams' which assumes dreams to last only a fraction of a second, despite being remembered to have lasted a long time.

continuation of an activity. This implies that ideas can contain a multiplicity of 'projected thoughts', as described above.

5.1.3. Fragmented "Flash Model"

Ideas are not restricted to the possibilities of the activity itself, they also integrate personal knowledge of musical texture and voice leading. As a result a possible realisation might stem from a combination of several simultaneous alternative thoughts. For example (see Figure 5.3), new ideas can be consciously developed by means of counterpoint, fragmentation and overlaps from a multitude of projected ideas. Such approaches might be most coherently compared to compositional techniques, not by claiming their consistent and consequential application, but rather as loose methodologies to extend the musical potential within projected possibilities.

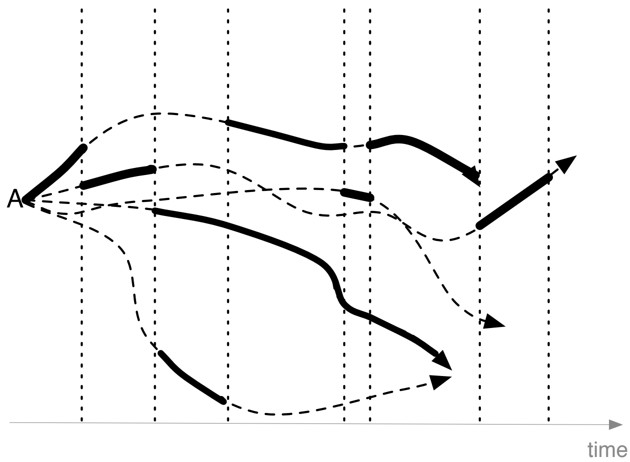

Figure 5.3: Fragmented "Flash Model": actualisation through fragmentation of initial ideas. Dotted lines indicate 'slices' of time to indicate the fragmentation and counterpoint of the ideas. Dashed lines are part of the projected possibilities, the black line symbolises the ideas actually realised.

An important aspect in the discussion of improvised approaches is that the activity of a performer gravitates between individual methodology (individual voice), adjustment to other influences[399] and conscious attempts to break with one's own voice through experimentation. Such moments reveal that any linear formulation of the thought processes can only work upon reflection and retrospective study of the sonic outcome; after the thoughts have been actualised. It is only possible to analyse a performance and suggest feasible causalities after it happened. The cognitive processes which were underlying the actualisation did not happen linearly (as shown in Chapter 3.9), the order

[399] In most obvious forms that would entail reacting to other players, but this condition also exists within solo improvisations. So the 'other' is meant here in the widest sense of the word.

of occurrence of the activity during the actualisation is likely to differ from the order of the ideas were conceived. We also have to note that the actualisation happens within 'real-time'; the perceived time passing while one is engaged in the activity. Heidegger states that "[w]e are accustomed to contrasting the 'timeless' meaning of propositions with the 'temporal' course of propositional assertions."[400] Ideas are formed within an instance and contain envisaged possibilities to be projected over time. The idea how one's current action can be coherently linked to the next might have been thought of at a later stage (exemplified in Figure 5.4: Event 1 would be played before event 2 during a performance, although the event 2 was conceived before event 1).

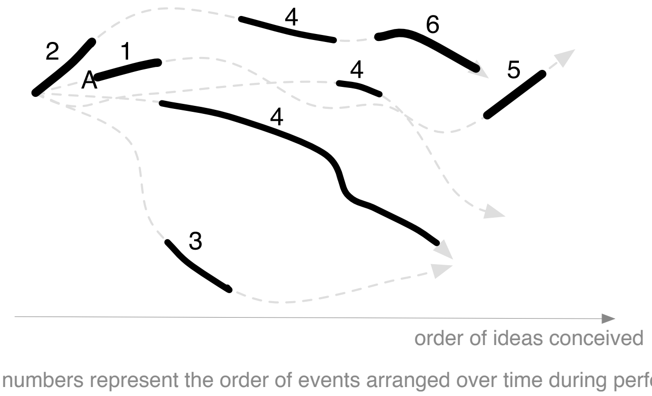

Figure 5.4: Timeless fragmented "Flash Model": Projected ideas need not resemble the temporal discourse of the actualisation.

To prove these propositions beyond their proposed conceptual coherence and validity exceeds the means of the author and might even be impossible at all. The personal memory of what has happened during a performance on such levels appears subconscious, i.e. it is often impossible to judge that what one consciously remembers of a situation is actually how it occurred. Julius Kuhl's PSI theory has been an important source in terms of its suitability to describe possible cognitive activity and their causal relationship to ideas, intent, knowledge, skill and experience. It is proposed that Kuhl's theory provides the scope that the affect-regulated balance between the intentional processing of the IM[401] and the holistic experience and knowledge available in EM [402] make this final adaption of the flash-model a feasible appropriation. It allows the multiplicity of ideas, their non-linear fragmentation and layers to emerge through continuous exchange between the IM and EM. Furthermore, the evaluation of the music (the actualisation of the musical ideas) affects the balance between the positive and

[400] Heidegger 1962, 39.
[401] See Section 3.9 page 93.
[402] See Section 3.9 page 94.

negative affect, which in turn influences how the IM and EM are used in the next moment.

As shown in Chapter 4, ideas can focus rather on methodological progression than thematic and sonic considerations. The structure within the actualisation might only emerge from applying the idea of a physical gesture (e.g. stroking, bowing etc.) or underlying attributes (rough, smooth, loud, soft, sparse, dense). When this approach is applied in performance situation, conscious recapitulation to a previous idea might not be recognised. In this context it is also questioned whether reducing ideas to musical content is inadequate in improvisation. Ideas ought to equally deal with aspects around performance itself to allow the activity to be moved into a new direction, to increase one's awareness of what is happening around one, to allow the proceedings to come to a rest, and recognising the moments of closure.[403]

5.1.4. Ideas as Movement in Spaces

The strategy to overcome the limitation in discussing and describing the performance practice focusing on these non-linear aspects has been the adoption of Sloterdijk's spherical model. The model reflects the geometrical representation of thoughts, as applied by Gärdenfors, "to present the notions of dimensions and domains that constitute the fundamentals of [his] theory of conceptual spaces"[404] to overcome the shortcomings of "symbolic approaches [... where] cognition is seen as essentially being *computation*, involving symbol manipulation"[405]. But, a more relevant approach for this research was found in the spherical metaphor employed by Sloterdijk.

Peter Sloterdijk describes human nature and social relations in the metaphor of bubbles (Sphären I, Blasen[406]) for personal and micro interpersonal relationships, globes (Sphären II, Globen[407]) for macro organisational relations, in its extremes globalisation of politics and markets, and foams (Sphären III, Schäume[408]) to discuss alternatives to the prevalent social structures. The spherical metaphor of the bubble describes the

[403] The concept of closure, a aesthetic recognition that a performance has reached its end, appears to be one major issue in the development of generative algorithms.
[404] Gärdenfors 2004, 30.
[405] Gärdenfors 2004, 1.
[406] Sloterdijk 1998.
[407] Sloterdijk 1999.
[408] Sloterdijk 2004.

creation of a personal "inner space" (Innenraum) encompassing the individual. Human motivation, intent, experiences, education, traditions and culture are illustrated as equipping our "inner space".

Sloterdijk also states that the human depends on pairings from the earliest stages of life. From the elementary linguistic indicator that one can 'be beside oneself' it is argued that human existence is defined through an opposite part, which is not in itself necessarily definable as a physical entity[409]. Although Sloterdijk's discourse is a complex philosophical and psychological journey through human nature and the world, it serves as an inspiration to adopt a simplified abstraction of his concept to look at the relation of two opposing or complementary poles. Human perception often relies on defined opposites: e.g. perception of sound requires a concept of silence and light necessitates an experience of darkness. But a gradient often exists between these opposites, defying concrete definition but nevertheless existing in various resolutions. To illustrate this (Figure 5.5) one can consider a gradient from yellow to blue. The dotted arrow indicates the length of a gradient of the continuum of the mixed colours from yellow to blue.

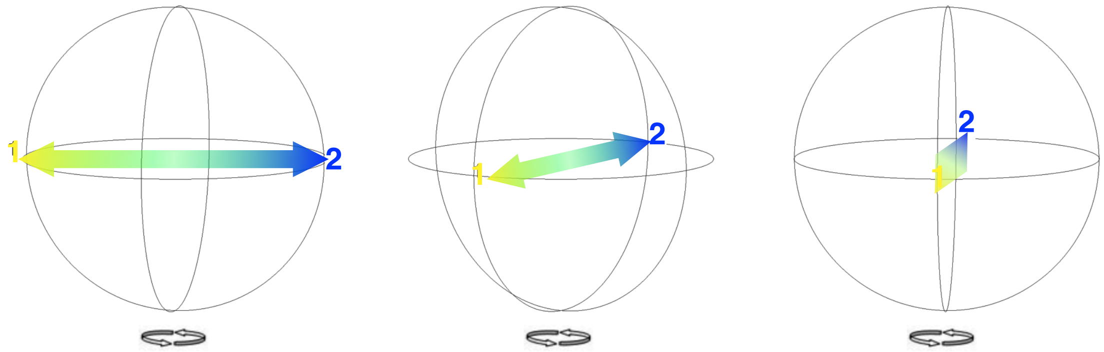

Figure 5.5: The length of the dotted arrow represents the perceived gradient of the continuum between the two poles.[410]

Personal perception might show differences of gradients between the two colours dependent on context and interest. Such changes in perspective can be taken as a rotation of the sphere. Two possible interpretations can be taken from this rotation: Firstly, one idea comes to the foreground and starts to be more 'important', 'closer' or 'immanent'. In the fictive example above, the importance of yellow would increase, reducing the concerns about the gradients. So the perceived distance of the poles shrink within the two dimensional projection of the sphere. The opposites of yellow and blue

[409] Although Soterdijk makes references to the placenta in which earliest life is forming.

[410] Colours chosen for this example are in accordance to Johannes Itten's colour wheel (http://en.wikipedia.org/wiki/Johannes_Itten) last visited 20.07.2012.

would be strongest in closest proximity to each other. Ideas which are on an equal level have the maximum distance, ideas of unequal position move simultaneously closer. This abstraction is proposed as a means to describe sudden shifts into opposites and contrasts or gradual transitions from one to another.

Changes in perspective (rotation) can occur through various individual shifts in personal perception. The rotation – the changes in perception – can have various reasons: Either further, more detailed knowledge about particular concerns has altered the perception, or more short-term changes such as a feeling of excitement or boredom etc. can be the cause. It is also important to realise that changes in perception are not necessarily concurrent with changes in the activity. For example: the repetition of a particular pattern could cause a gradual rotation while the musical activity remains the same. An idea can therefore start to divert from the initial thought while the physical execution has not changed; it equally might not change at all. Further rotation could shift the perception in such a way that staying with the same activity appears to be appropriate after all.

The importance of one concern can alternate with a second through the rotation; but also new points on the gradient between the poles can come into a more detailed focus, that our perception might define this as a new pole. Figure 5.6 illustrates this by reusing the colour examples of yellow and blue. A point forming a mixture of yellow and blue might develop a distinct quality within the previous continuum, which form memorable characteristics and become clear distinguishable as green[411].

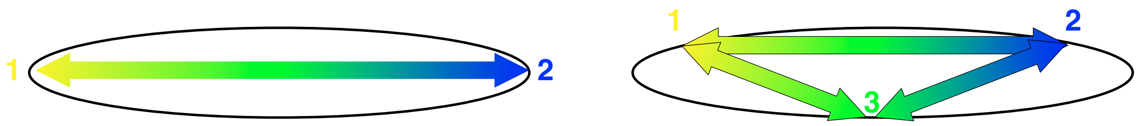

Figure 5.6: Birth of a new pole. The reverse can be considered too: The death of a defined pole.

This symbiosis could be considered as the birth of something new (adding poles to the sphere), but the reversal, the disappearance of a defined point, is possible as well (deletion of a pole), in particular as the origin of something new might render a previous

[411] Therefore the perception of the gradients between yellow and blue are not perceived as “**yellow**”, “yellow > blue”, “**yellow = blue**”, “yellow < blue”, and “**blue**” anymore, but as two continua between the yellow-green and green-blue scales:
“**yellow**”, “yellow > green”, “yellow < green”, “**green** (**yellow = blue**)”, “green > blue”, “green < blue”, and “**blue**”.

concern obsolete[412]. However memory, with the ability to retrace processes and to evaluate outcomes etc., facilitates all different states simultaneously.

5.2. Personal Space

Many philosophical investigations relate or establish concepts of the self and its relation to the other. Sloterdijk stresses that instead of the self as an individual, the couple ought to be given more importance, as the "human sphere is [...] from the beginning, literally *ab utero*, bipolar at first, and in more advanced stages pluripolar".[413] "The human, as far as he is the being that »exists«, is the genius of neighbourhood [community]"[414]. The human being defines his/her world by relating to another, s/he creates bubbles within which s/he exists and by which s/he defines and describes his/her surrounding. Agamben indicates also the deep routes of this dichotomy – or more appropriately, the interdependence of the self and a contrasting other – by enlisting words concerning the self and our place within the social and private[415]. In this manner "self", "itself", "to accustom oneself", "habit", "companion", "character", "alone", and "separate" are all related to each other through an ancient word cell which Agamben defines as the "reflexive *se [... that] indicates what is proper [...] and exists autonomously"[416]. The personal space is therefore at first an outline of the relationships between the one to another, whether these are in forms of social interrelations, habits and tradition. But the relationship to objects, their material and their use as tools and instruments are equally part of the personal space. Memories can be attached to particular objects. The objects can trigger and stimulate emotional responses and facilitate personal activity – a quintessential subjective relationship to objects. Objects have an objective consistency attributed which defines its physical characteristics, which are assumed to be the same for every subject. While this is a truism concerning the chemical compounds of the

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412 The aspect of making obsolete is often embedded in the concept of development, new discoveries and developments eliminate previous stages.

413 Sloterdijk 2004, 14: "Der Humanraum ist [...] von Anfang an, buchstäblich *ab utero*, zunächst bipolar, auf entwickelteren Stufen pluripolar geformt;" Translation by Elke Schwarz.

414 Sloterdijk 2004, 14: "Der Mensch, sofern er das Wesen ist, das »existiert«, ist das Genie der Nachbarschaft."

415 Agamben defines *se as the linguistic root.

416 Agamben 1999, 116.

material and its physical characteristics of mass, surface and shape, the potential of the objects appears to be a more subjective affair.

5.2.1. Objective – Subjective

It is not necessarily attempted here to negate objective values and the consideration of objects and processes as “proper”[417] and self-contained entities in order to find more universal relationships in the human/world dichotomy (being-in-the-world[418]) and to enable seeing beyond the phenomenological value and appreciation. However, the appreciation of the hierarchical order of placing the objective above the subjective relationship has to be questioned. In consequence, it is advocated that the objective and the subjective are seen as poles of a continuum. This enables us to abolish the opposite characterisation while still maintaining their definitions. Furthermore, one should differentiate between the subjective and the emotive, since therein lies the difference as to how the world around us is perceived. The emotive is in some respect considered here as problematic in relation to musical performance, as it forms the basis of mere self-expression: “I record that this is how I feel”[419]. A brief excursion into Heidegger’s philosophy of Being will elaborate this distinction. The conventional conception of emotion describes the relationship of the mind to the body and environment within a frame of time, it is “being-with-oneself”[420]. This is only one part of the “Dasein” (being). Emotion is, although closely related, in contrast to Heidegger’s use of “Befindlichkeit” (affectivity) which relates to the emotional state of being as “an ‘interactional’ concept, rather than an ‘intrapsychic’ one”[421]. As a result the subjective is the individual relationship to the world, inclusive of oneself as part of that world, thus it is the “being-in-the-world”. To define an objective state is an attempt to develop a “human-in-the-world”[422], for which the detachment from an individual is part of the methodology to gain an understanding of universal aspects in human behaviour. The

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[417] Agamben 1999.
[418] Heidegger 1962.
[419] Cardew 2006, 132.
[420] Heidegger 1962.
[421] Gendlin http://www.focusing.org/gendlin_befindlichkeit.html, last visited 25 Sept 2011. She also offers a very coherent differentiation between the German and English use of emotion/feeling: “In German a common way of asking "How are your is "Wie befinden Sie sich?" This literally says "How do you find yourself?" One can also say to a sick person "Wie ist Ihr Befinden?" ("How do you feel?") The same form can also be used to say that something or someone is situated somewhere, or in some way. For example, one can say, "The White House finds itself in Washington, D.C.," or "I find myself in Chicago," or "I find myself in happy circumstances."”
[422] Heidegger 1962.

"potentiality-of-being"[423] is not the objective relationship of 'human-in-the-world' alone, it is at least the sum of all 'being-in-the-world', which Heidegger calls the "authentic" and thus not merely incorporates what might be described – within a particular cultural and aesthetic setting – as the absolute and the objective. Any process of de-individualisation for the purpose of methodological and objective understanding has to be considered as an attempt to uniform the personal sphere. This is of value to scientific research to develop a greater overall understanding. But individual diversity persists, portrayed and exposed most vividly in artistic activities. This facilitates individual development of one's own understanding of the relationship to the entities around us. After all, the value in art lies in its ability to convey meanings where language ceases to portray relationships.

5.2.2. Building Personal Spaces – Equipping One's Inner Space

Sloterdijk had shown that human existence is never without an 'other'. From the point of conception, the human being is in an intimate relationship with another entity, starting with impressions in the womb. Although the embryonic world is enclosed, the early development of the sense of hearing connects the new life with its surrounding. One of the earliest human tasks is the need to learn to distinguish between sounds which are important[424] and those which can be ignored or are distractive[425]. The intimacy of the baby with the parents, specifically the mother, is identified as significant after birth. In the process of growing up, an ever widening cycle of impressions and relations through family and other social structures gains influence. In this process the individual 'inner bubble' is formed and equipped – the 'Austattung des Innenraum'.

Interpersonal engagement is like an interaction of at least two such bubbles. When bubbles overlap with each other easily, an intimate and deep understanding might appear between the two individuals. Metaphors describing the close proximity of spheres and the way their surface areas might touch can stand for social situations. They can elaborate if individuals feel comfortable, if their situation is only acceptable within compromised conditions, and whether clear boundaries are cultivated unanimously, despite a certain comfort with the other. Disagreement and conflict causes the surfaces

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[423] Heidegger 1962.
[424] The vocal sounds of the mother. Hüther 2006.
[425] Relentless sound of the heart beating, noises from the digestion etc. Hüther 2006.

of the bubbles to bounce off each other, as they are in contact with each other but would neither overlap nor share a surface area.

We have numerous expressions utilising this metaphor in our daily life: “it is as being one”, “our ideas melted together”, or “we bounced off each other”, “we were engulfed by an idea”, “we felt as if being pierced”. The physical body is extended to an existence which includes the personality, the charisma, the aura, the individual presence that is felt beyond actual physical touch. We speak of someone entering our head, in a positive sense when one starts to get involved with another person, in a negative sense when someone appears to be manipulative.

5.2.3. Objectifying the Personal Space and Making it Uniform

Objectifying the personal space can happen through laying out the blue-prints of how the ‘inner space’ ought to be equipped in order to make them uniform to others. This can be considered as an extension of a singular bubble that assimilates others. In its extreme Sloterdijk describes this as cultural and political globalisation: a singular culturally and politically formed bubble attempting to be extended into a globe over-spanning the entire world. The individual but uniformed bubbles are cells within a greater entity, being immersed within an engulfing idea. Although this extreme form of globalisation, appearing within voluntary and involuntary circumstances, has a contemporary international political relevance like never before, it is also present in smaller social structures. Where a singular bubble is extending to submerge others, i.e. where one idea is presented to convince others of the same, an individual bubble is expanding into a larger entity, a globe. These metaphors can be utilised to describe political and social structures: For example, feudalistic and totalitarian structures are singular bubbles extended to include others, irrespective of the individual. The socialistic is an utopian conceptual bubble, created under the premise to provide a space where each immersed individual is equal. Western capitalism might appear at first as a greater structure enabled by independent individualistic bubbles. But, as the current politics reveal, the ideas of globalisation fundamentally rely on uniformity. Market forces connote that citizens ought to voluntarily adopt particular spaces in order to facilitate expansion and success of one’s own bubble. In all these cases, the political sphere utilises the metaphor of an closed ‘inner space’ which attempts to create an immunity to possible threats from the outside, in similar ways as the individual seeks security for the 'self' in relation to the 'other'. This quest for immunity is not necessarily in form of active defence and violence. It can instead constitute itself through attempts to accommodate the 'other'. The bubbles (also described by Sloterdijk as the immune system) grow in this "immune-strategical" process to larger entities (globes) as the "imperialistic ideal aims for the control of the entire world"[426]. Here one can see a close relation to the problems mentioned of the 'objective' as the 'absolute'. This is also exemplified by Sloterdijk's argument that the unavoidable failure of the "classical metaphysics" was not caused by "sobering critique and increased knowledge"[427]: It came about through its own conflicts to "defend the object of life" – the individual bubble – while "simultaneously taking side with the infinite, which denies each and every living being , and ignores private immune-interests".[428] The inconsolable rift between these poles can be seen within social structures on every level. The awareness of the self, its relation to the other, and its role within an over-spanning organisation appear to become problematic as soon as the attempt for self-immunity, either by devotion or domination, becomes too pronounced. The individual acceptance of being a cell of something greater restricts individuality. If this relationship is reversed, the egoistic behaviour compromises the 'other', as the doctrine of self-interest (a part of immunity) has to limit and regulate the interests of other 'private immune-systems' to reach their goal.

The mixture of how the relation between 'self' and 'other' are organised remains as the difficulty within sociopolitical structures. Many religions, for example, have an established function to deliver a concept of infinity that promises immunity of the 'self' by assigning itself to a greater 'other'. In turn it is accepted that individuals are regulated by moral and rules, which might be enforced through violence or forms of punishment. The conceptual requirement for penalisation, utilising detention, expulsion, exclusion and extinction of those stepping outside or threatening the fabricated "inner space" of the global bubble, is a sign of the fear of a loss of immunity. To protect the

[426] Tuinen 2007, 57.
[427] Sloterdijk 2004, 18.
[428] Sloterdijk 2004, 19.

ideals the means have been set to "decide how to settle any given controversy"[429] rather than allowing processes "to trace connections *between* the controversies themselves"[430].

Social regulators also appear within Zeitgeist, fashion and tradition, where stylistic attributes become implemented in one's life, work and appearance to indicate – but also influence – one's association and affiliation[431]. The extent of this is only mildly expressed when Dell states that the "commitment, sustainability and social integration have the capacity to facilitate action, but may also be limiting"[432].

5.2.4. Infinity and Immunity

The dichotomy of "infinity and immunity" permeates modern thoughts through which the 'mono-centric metaphysical thinking was dismantled'[433]. New theories define global goals claiming infinite and objective values, which attempt to regulate the subjective in some form or another to increase its own immunity. But this in itself bears dangers, as Sloterdijk debates in picturesque language. In his opinion, the closely related dichotomy

[429] Latour 2005, 23.
[430] Latour 2005, 23.
[431] Poster found on http://foundations3ddesign.blogspot.com/2011/05/relief-poster-assignment.html, last accessed 25 Sept 2011.

For a better start in life start COLA earlier!
- Promotes Active Lifestyle!
- Boosts Personality!
- Gives body essential sugars!
How soon is too soon?
Not soon enough. Laboratory tests over the last few years have proven that babies who start drinking soda during that early formative period have a much higher chance of gaining acceptance and "fitting in" during those awkward pre-teen and teen years. So, do ourself a favor. Do your child a favor. Start them on a strict regimen of sodas and other sugary carbonated beverages right now, for a lifetime of guaranteed happiness.

[432] Dell 2002, 139: "Verbindlichkeit, Nachhaltigkeit und soziale Einbindung ermöglichen nicht nur Handeln, sie schränken auch ein."
[433] Paraphrased: Sloterdijk 2004, 20.

of sedentarism and nomadism shows that waste accumulation can threaten settled organisations, while the nomadic escapes to new places, leaving the waste behind; adding metaphorically to Wittgenstein's image of the ever incomplete infrastructure of a city the connotation of the "odour of waste" to warn from the "danger to the immunity efforts from within itself"[434].

In the modern world such dichotomies are resembled by technology as well: On one side it supplies the tools to expand individual influence of the human spheres and helps to shape the inhabited space to increase internal security. On the other side technology facilitates activities which might destroy social interactivity. For instance, technology only appears as a remedy for the human longing to escape obsoleteness in terms of rendering their actions and communication into idealised virtual simulations and channels. "The virtual is ideal but not abstract, real but not actual." [435] People spend time engaging with life in realities which can exist irrespective of a person's location. They develop to act and communicate in worlds which are alien to their actual environment. Sloterdijk indicates that the tele-communicative globalisation has taken over the terrestrial. The individual bubble can connect and communicate outside its immediate physical proximity, thus the "integration of manhood in a super-tribal »psychical society«"[436] by means of computer networks. This enables "a hybrid, tribal-global information-sphere, which engulfs us all as exhilarated and coerced members in a »single, universal membrane«"[437].

There is also a gulf between technology facilitating one's work and the demand to use prescribed technology to access and to remain within imposed expectations in the social spheres. The induced notion of a perpetual development can lead to the utilisation of technology for the sake of itself. This generates a smokescreen to impress through progress and modernness, rather than convince through responsible exploration and scrutiny. To go even a step further: some technological developments depend on advertising campaigns to make people believe that they would facilitate creative

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[434] Sloterdijk 1999, 347.
[435] Shields 2003, 43.
[436] McLuhan discussed in Sloterdijk 2004, 23.
[437] McLuhan discussed in Sloterdijk 2004, 23.

thoughts and work in order to mask their limited and defined “code of creativity”[438]. Either way, a glorification of technology is taking place which can reach quasi-religious status and reveal itself as part of the prominent expanding global spheres that claim to supply the remedies for creativity, happiness and security.

5.2.5. The Personal Space Extrapolated

An excursion into the political domain might at first appear far fetched and unrelated to the description of a performance practice involving electronic means. However, it is proposed that the role of technology within the musical activity enables similar expansion beyond the personal field. It can facilitate individual, interpersonal and social aspects of a previously unachievable scale within performance[439], but on the other hand it unifies and dedifferentiates the means and approaches to creative musical work. This insight is not solely exclusive to electronics: any advances in instrument design facilitates and optimises particular practices. After these become gradually identified as stylistic components they might begin to formulate directives that are adopted in further practices. Music technology enables methods of production and workflow to be narrowly determined by programmers to serve a particular clientele of users as a means to establish a niche market for their personal commercial success. In addition, the development of stable software requires clearly outlined features to preserve economic value. However, such software will in turn influence the prospects of creative work[440], in particular if the program features were conceived so that its users unwittingly create the programmer’s notions of art.

Emmerson discusses convincingly how within the performance space itself technology can modulate the relation between “local controls” and “field functions”: “Local controls and functions seek to extend [...] the perceived realisation of human

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[438] Here are parallels to Attali comment on statements by Boulez and Levi-Strauss on creativity: "nothing ... confirms the validity of these value statements, which confuse creativity with the present code of creativity." Attali 1986, 145-146.

[439] For example: use of technology to add accompanying parts, exploration of different means of communication within ensembles, including networked performances and audience participation.

[440] This has been a very prominent consideration in the development of the *piano+*. While the programming itself required extensive time involvement, experiments with available software always appeared to discourage particular lines of interest, as e.g. the entire system Ableton Live demands to think within a bar structure, disabling unquantised recording for instance. This reveals that the prime concern has been to serve the prevalent beat-based musical structures, so that it appears to be assumed that a new recording is always starting at the beginning of a new clip. This restriction prevented even the loop-artist Beardyman to work with the software in correspondence to his musical understanding about working with looped layers in real-time, which required him to develop a custom software.

performer action to sounding result" [441]. While this incorporates the means to augment instrumental qualities, it also considers the extension of the performance into the concert space through amplification and diffusion systems. "Field functions", on the other hand, "create a context, a landscape or an environment within which local activity may be found"[442] – in other words: imploding an environment into the concert space. Emmerson presents technology as a means to manipulate the perception of the space and performance activity to increase the spectacle of an event. These approaches are further extendable by the use of visual projections. Aural and visual conditioning of the performance event and space have close links to what Sloterdijk[443] describes as the human attempts and determination to design the spheres they inhabit: The pinnacle of which he identifies as air conditioning.

Improvisation has been defined in this thesis as an investigation of the personal sphere and a continuous negotiation with the 'other', whether the 'other' is the instrument or consists of other personal 'immune' systems (bubbles). It certainly engulfs the personal interests and concerns, whether they are ideological, theoretical or environmental and span from the individual to the social and political. Hence the role and potential of technology becomes inevitably a fundamental concern within the performance practice, rather than an option to increase the spectacle of performance. The presentation of technology in itself is irrelevant, but the means by which it is applied obviously not. Inspiration and research from a wide range of topics is required to develop a performance system which allows us to transcend operational tasks of the electroacoustic augmentation in order to pursue musical and socio-political interest within free improvisation. An underlying theme throughout this thesis is to establish and describe instrumental, personal and social spheres which interact, merge and generate frictions in several ways and forms.

When the metaphor of the bubble is applied to issues arising from free improvisation and the use of the augmented instrument, a unifying terminology and approaching language can be found for the theoretical, technical and practical considerations. The processes to acquire the personal "rational and total knowledge"[444] equip our "inner

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[441] Emmerson 2007, 92.
[442] Emmerson 2007, 92.
[443] Sloterdijk 1999.
[444] Dell 2002, 197.

space" within the given social, cultural and traditional influences . To equip one's "inner space" also involves the acquisition of skills to employ instruments and tools, which again are dependent and influenced by the cultural and technological background and sophistication.

Therefore, on the personal level, it is 'Me' who selects concerns, whether they are about improvisation or reminiscent of compositional methods, whether they are about acoustic or electronic, whether they are about nature or technology. It is 'Me' who equips the personal space with these elements to reflect personal opinion. It is not that 'Me' is situating 'Myself' within the subject(s), rather it is 'Me' who potentially decides to focus on one particular aspect to find out more about it, because 'Me' envisages gaining more insights and understanding from it.

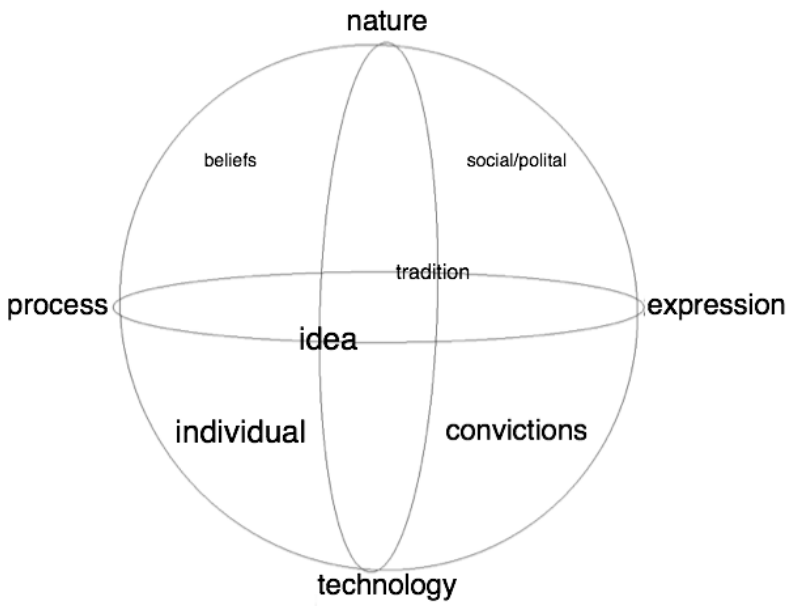

Figure 5.7: Abstraction of a possible personal sphere[445]

The focus of concern can shift during a process. A particular concern is in the consciousness while one is working on an idea. This idea might then be consciously left aside, as if one shelves a concern in surrounding cupboards and cabinets. This does not equate to discarding the concern, but to lessen its immanent importance, which might imply that one is temporarily forgetting it. This corresponds to Kuhl's description of ideas and thoughts being exchanged between the IM and EM[446].

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[445] To clarify the opposite poles in Figure 5.7: nature – technology, process – expression, idea – tradition, individual – social/political, convictions – beliefs.

[446] Compare with PSI theory (Section 3.9).

None of these concerns can be detached from the ‘other’, neither in terms of the instruments one engages with nor in the ‘field’[447] one is placed in. An instrumental sphere merges into the personal sphere through the experience gained from engagement and through the resulting accumulation of techniques and understanding. The instrumental space is never fully encapsulated in the personal space, because the potential of the instrument will always exceed what one possibly knows about it. Social aspects with other personal spheres are indescribably more complex. Predetermined and descriptive strategies and methodologies, either portrayed, explained, discussed or scored[448] attempt to merge and align personal spaces prior to the activity. Or – from the perspective of the performers – individuals are required to subscribe to a set of given descriptors[449].

Sloterdijk’s third spherical metaphor – foam – becomes relevant as he explores the viewpoint that “»life« unfolds itself multifocally, in multiple perspectives, and heterarchical.”[450] We engage in a

> “life [which] creates boundless multiplicities of space, it does so not only because each monad [microsphere] has its very own environment, but even more so because each is entwined with other lives and comprised of countless units. Life articulates itself on intricately interlaced stages, it produces and consumes itself in networked laboratories. [...] It lets the space, within which it exists and which is within it, emerge.”[451]

Within a performance practice inspired by this spherical metaphor, the performer is aware of being part of something, not just as a cell, but as the whole being, mindful of the shared authorship of the resulting activity. The activity would not exist without the ‘other’; the activity of the ‘other’ would not exist without one’s own *responsible* contribution.

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[447] Using Emmerson’s definition of ‘field’.

[448] These are means to extend the personal sphere of influence, see discussion about globalisation above.

[449] Considering oneself as cell of a greater sphere.

[450] Sloterdijk 2004, 23 “[...], daß das »Leben« sich multifokal, multiperspektifisch und heterarchisch entfaltet.”

[451] Sloterdijk 2004, 24 “Wenn »Leben« grenzenlos vielfältig räumebildend wirkt, so nicht nur, weil jede Monade ihre je eigene Umwelt hat, sondern mehr noch, weil alle mit anderen Leben verschränkt und aus zahllosen Einheiten zusammengesetzt sind. Leben artikuliert sich auf ineinander verschachtelten Bühnen, es produziert und verzehrt sich in vernetzten Werkstätten. [...] Es bringt den Raum, in dem es ist und der in ihm ist, jeweils erst hervor.”

5.3. Revisiting the Instrumental Space as the Potentiality Space

The spherical model has facilitated the conceptual abolishment of the defined entities 'instrument' and 'performer'. There are similarities to Heidegger's distinction of tools to be "present-to-hand"[452], as long as they are considered as an object in itself, and "ready-to-hand"[453] after the tool "is totally absorbed into our projected purpose"[454]. This "primordial relationship"[455] to the tool is not regarded here as the sole purpose to merge the instrumental space with the personal. It is within the conscious alteration of what constitutes the instrumental and the personal that it becomes possible to consider each as poles within a continuum that enables us to unlock further potential of the instrument. Unquestionably the 'ready-to-hand' facilitates the fluent use of the instrument within performance and allows technical aspects not to interfere with the concentration on the music itself. However, reminding oneself of the instrument as 'present-to-hand' might reveal more of the instrument's potential and indicate new directions the performance could take. This is applicable to any part of the proposed performance system, the piano itself, the extended techniques and its tools, and the computerised augmentation too. The technical strategies and results were described in Chapter 4 and its practical consideration was influencing, in some respect even forming the conceptual approach. In this process conceptual spheres were populated with fields of interest as abstractions to Sloterdijk's equipping of the "inner space" (Innenraumaustattung).

It will be beneficial to revisit the methodological illustration for the acoustic extended techniques (Chapter 4) to exemplify this conceptual process. It was established how gestural aspects of the method of playing can also lead to coherent musical discourses. The presented methods were also outlining groups of methods following other shared characteristics which have been plotted into the spherical abstraction in Figure 5.8.

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[452] Heidegger 1962.
[453] Heidegger 1962.
[454] Thomas 1999, 68.
[455] Thomas 1999, 68 or Heidegger 1962, 98.

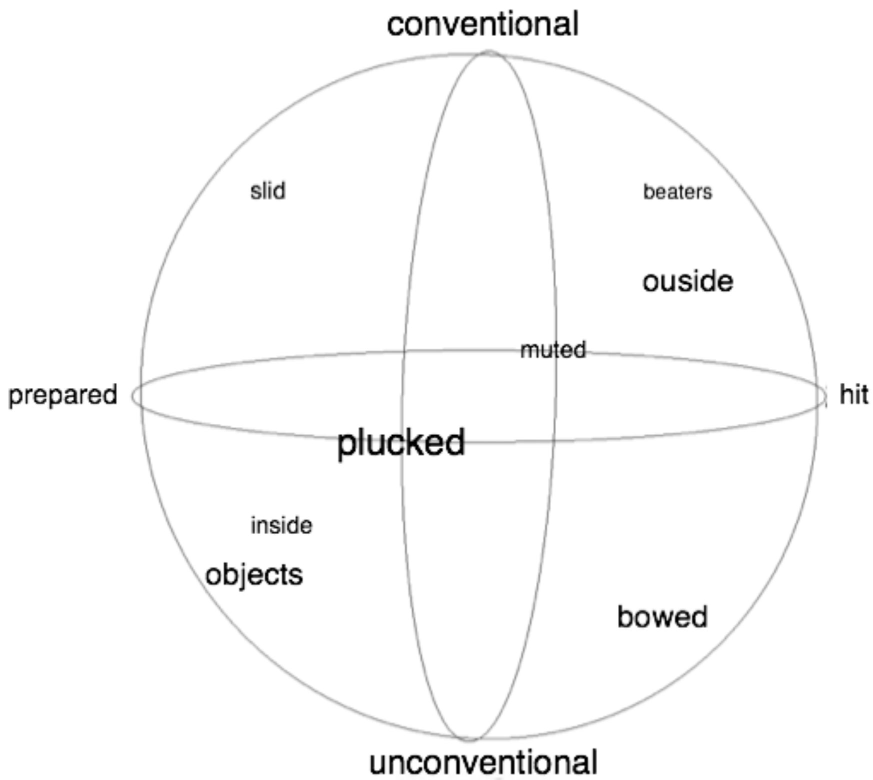

Figure 5.8: Abstraction outlining the characteristics of the acoustic extended techniques as introduced in Chapter 4.[456]

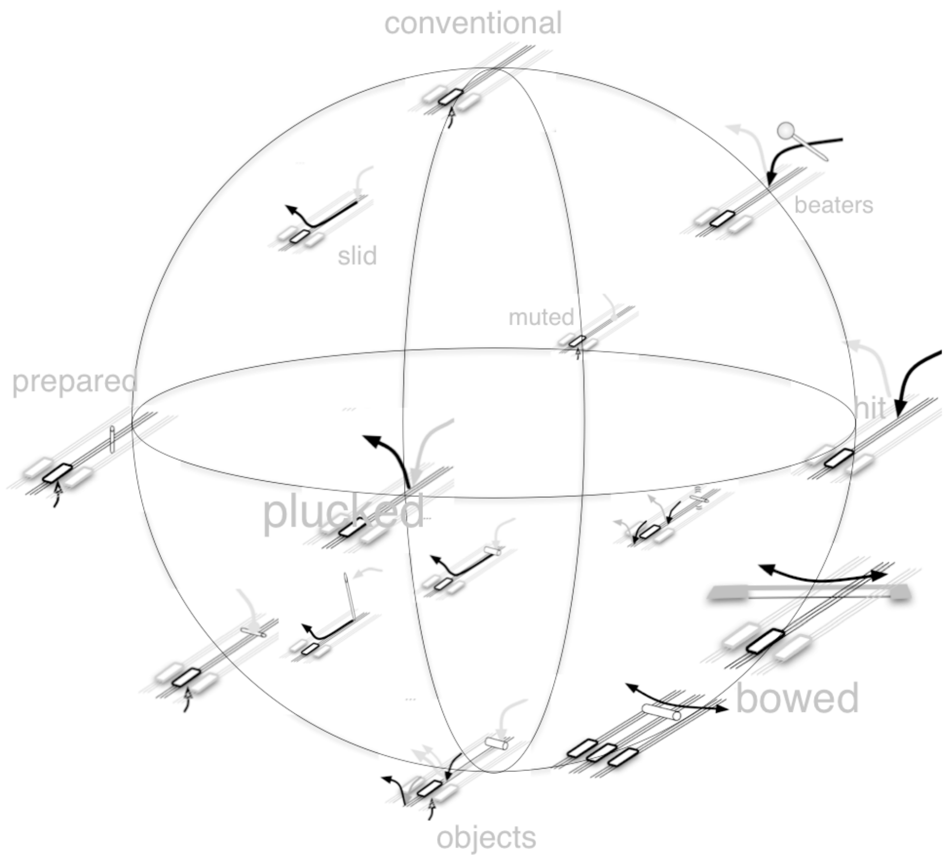

Figure 5.9: Abstraction placing methods of extended techniques.

[456] To clarify the opposite poles in Figure 5.9: normal (conventional techniques) – objects, prepared – hit, plucked – muted, objects – beaters, outside inside, bowed – slid.

Figure 5.9 is a three dimensional version of the score adding the actual illustrations of playing methods used in the 'example score' (Figure 4.1) to the spherical abstraction. The double arrows (in Figure 5.10) show the route of the performance and dotted arrows show some projected alternatives. The link between the different methods illustrated in this example assume a consideration of the instrument as "present-to-hand": To explore the similarities between gestures.

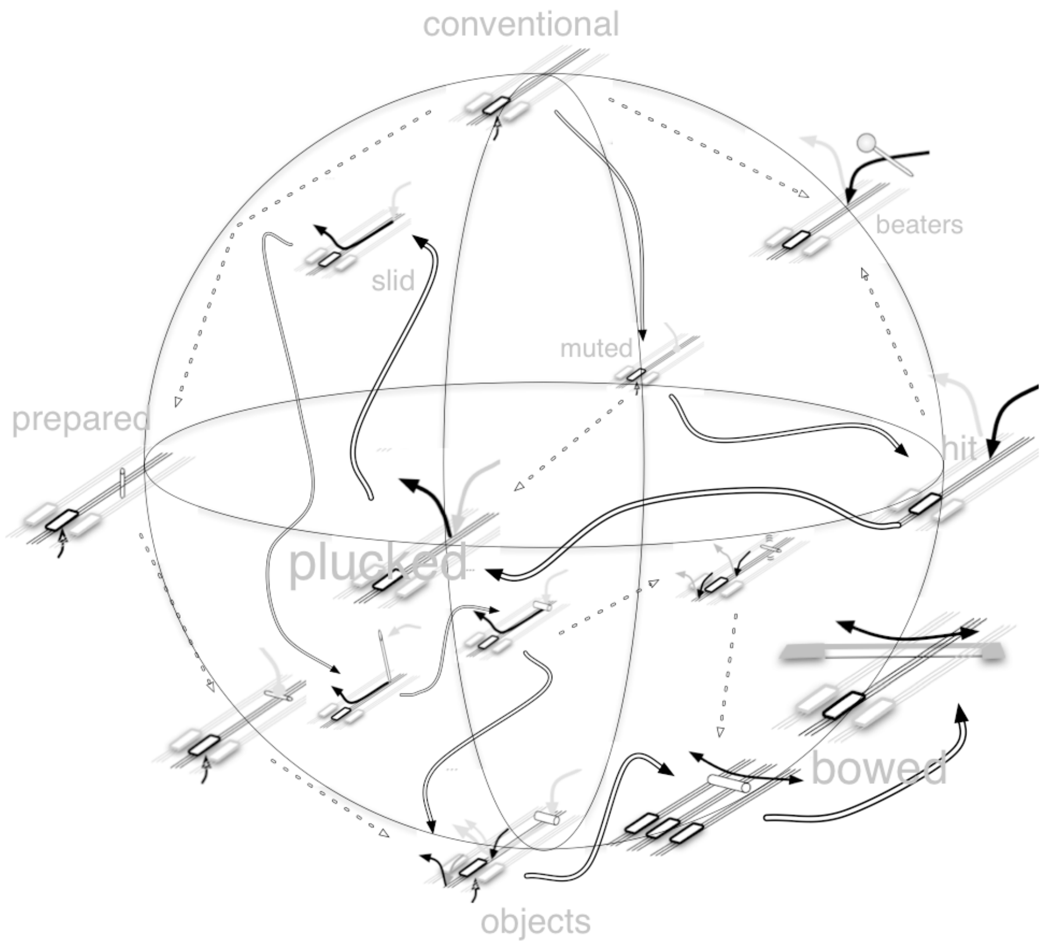

Figure 5.10: Three dimensional version of the gesture score (Figure 4.1).

The approach will most likely be a mixture of "present-to-hand" and "ready-to-hand" in an actual performance to allow musical fluency and exploration simultaneously.

The spherical abstractions are not proposed to score specific activities, but to outline concerns which the improvising musician encounters during performance. As the previous discussion has shown, the concerns can range from the musical, instrumental, to more general personal and socio-political concerns. In this manner the spherical abstractions might be encapsulated and engulfed in dependency to other spaces. For example, the detailed space abstracting the extended techniques of the piano (Figure

5.8) is encapsulated as a single pole ('extended techniques' in Figure 5.11) when considering the *piano+* in its entirety.

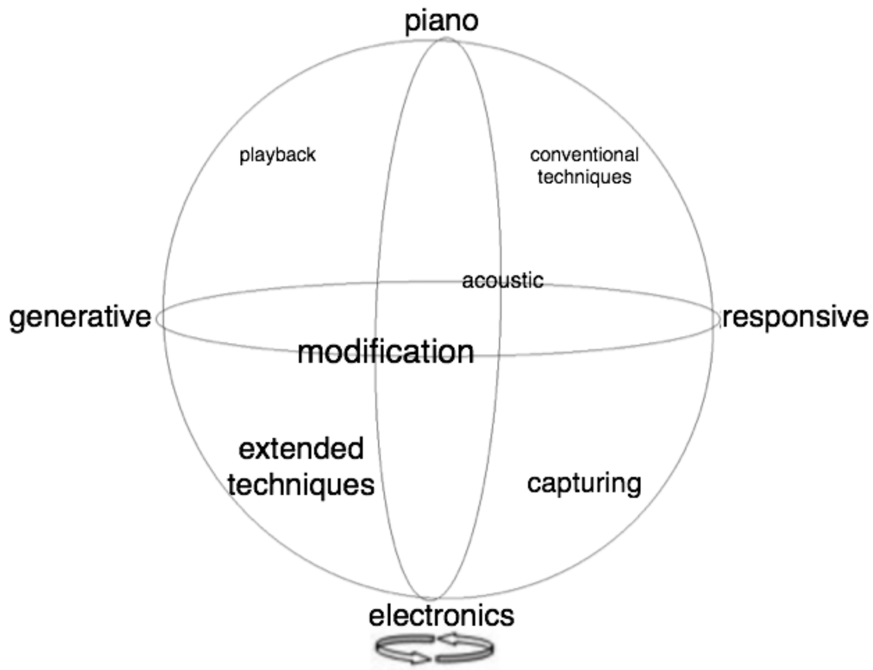

Figure 5.11: Abstraction outlining some areas of concern of the instrumental sphere of the *piano+*

Figure 5.12 focuses on the electronics by plotting relevant aspects into a separate sphere outlining areas of importance or interest within the software itself.

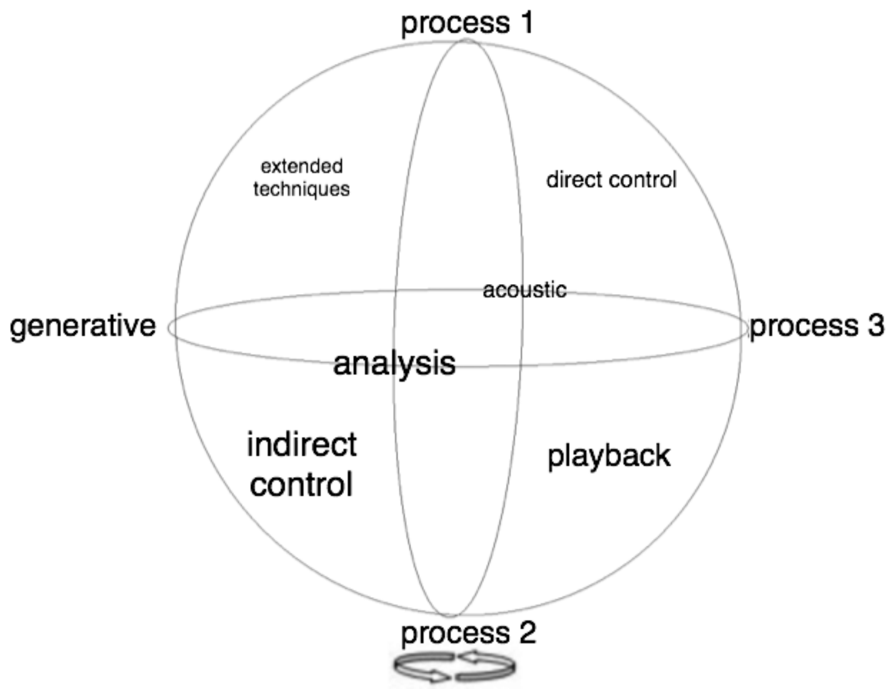

Figure 5.12: Abstraction outlining some areas of concern within the software design.

As described in Section 5.1, a conceptual rotation of the sphere changes the perspective and moves consciously or unconsciously different concerns into proximity or distance.

Any constellation is possible which reflects the differences and changes in the performer's perspective[457]. Descriptions of a performance practice are facilitated by combining different spherical abstractions which have been inspired by theoretical constructions outlined before. Before focus is given to the actual practical application and musical potential, the concept of improvisation (as developed in Chapter 3) ought to be incorporated more rigorously to this model.

5.4. Improvising Within the Metaphor of Space

The spherical metaphor adopted from Sloterdijk has been proposed to describe the combined complexities encountered on mental and practical levels when one engages in performance. It was shown that within the improvised performance an undeniable "personal voice", as Bailey notes, emerges, because the individually equipped personal space constitutes the "total knowledge" which influences the musical work. A philosophical interpretation of the "heuristic dialogue", described by Prévost, was elaborated within the conscious awareness of the potentiality embedded within the 'self' and the 'other'. In Chapter 3 an interpretation of a novel psychological model was also introduced to extend the understanding of the performance activity and underlying cognitive processes. All aspects concerning the performance practice have been related to a non-linear spherical construct.

The construction of an all encompassing imaginary space populated with relevant items of cultural affiliations, personality, memory, skill and approaches is proposed as a more cohesive approach to describe a performance practice based on free improvisation. Linear hierarchies and chronological orders can be conceptually eliminated from the performance and improvisation activity. The conceptual framework allows us to embrace aspects of spontaneity, adaptability, flexibility and continuously shifting focus, as well as catering for the knowledge, technical skills and experience. The spherical construction allows for the comprehensive re-arrangement of "items" as locations and areas in a space. These can also resemble the experience of events, for which an awareness of linear chronology in time is superseded by the non-linear perception of some appearing closer or more present than others. The possible shifts in focus and

[457] Same applies in moments of working on the project as a instrument builder or programmer.

awareness have been described as rotations of the spheres, enabling changes in perspective so that distance between ‘items’ will increase and decrease.

This is considered as a useful tool to understand the musical possibilities coming together in the process of the actualisation of the resulting performance. It enables us to counter assumptions that coherence in the overall structure is solely interconnected by sonic or musical features between individual events or by macro proportions of the structure. It is obviously possible to analyse aspects and proportions of structure on a musical basis alone – a scenario most certainly appropriate when recorded performances are considered – in the moment of observing a performance though, structure unfolds under complex influences of the musical, personal and social situation.

While an idea is realised, e.g. resulting in a musical texture which remains the same (e.g. playing a repetitive pattern (audio example CD *Dazwischen, Tone* 0:00 - 0:50 minutes), the perspective can change through the rotation of relevant spheres. In such moments the perceived music would not change, but the rotation of the spheres would alter the perception and appreciation. New ideas can evolve in response to an altered perception, as well as other projected alternatives might become more relevant. At any point in time thereafter, one of these ideas might be used to influence or alter the actual musical activity. Changes in perception do not necessarily influence the musical activity immediately but might only affect the evaluation of the activity. In an ensemble situation a participating musician might continue a musical texture because it accompanies someone else’s contributions, while awaiting a moment to introduce a more significant change.

It is proposed that this devision between activity and the perception thereof can serve as a comprehensive representation for initial excitement about what is being perceived turning gradually into an increasing satiation, and possibly even impatience and aversion. Within this model the spheres of concerns shift, affecting the evaluation of the ongoing texture. This is certainly not an explanation as to within what timeframe such changes can occur, and why. It is, however, sufficient to indicate that changes are motivated and how these might occur if the performer engages in the exploration of such imaginary conceptual spaces.

A spherical abstraction of musical attributes can elaborate this by detaching possible musical states from any particular personal or practical concerns. Figure 5.13 shows a hypothetical distribution of common attributes. While attempting to assign opposing attributes to opposite poles, this is nevertheless an arbitrary allocation, as the previous discussions have shown that the 'equipment of inner spaces' is within constant flux and change.

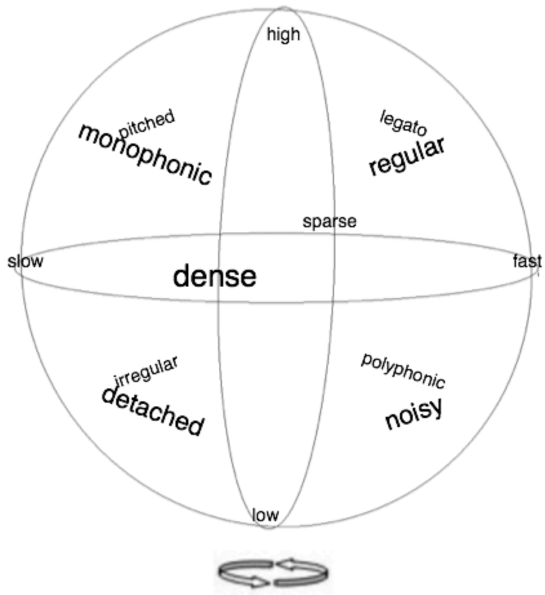

Figure 5.13: Abstraction of an 'inner sphere' of musical attributes

Supposing that the current perception would focus on the density, the close distance to the sparseness could initiate an abrupt change of the activity into a sparser texture (as it could be considered in the opening section of the audio example *Tone*). Equally, a 'journey' through the spherical space would gradually transform into the opposing texture, i.e. by reducing the speed of the activity to decrease the density. In the perspective of the sphere illustrated above, certain attributes appear impossible for an imagined transition. It would appear that slowing down the activity while increasing its regularity is not possible. This presented sphere is, however, only a snapshot within the evaluation of a particular musical moment (A). It can therefore be assumed that the idea to reduce the density is happening in irregular intervals, for example by increasing moments of silence in between dense outbursts of sound etc..

As a result, the actualisation out of the projected possibilities is described best as a combination of changing perspectives through rotation of the spheres and the proposed 'flash-model' (described in Section 5.1). The activity is fully integrated in the spheres, but sufficiently separate to allow cognitive processes not to interfere with physical execution. The sphere is a non-linear representation, so the length of the arrows representing the activity itself and the projected alternatives does not represent aspects of time.

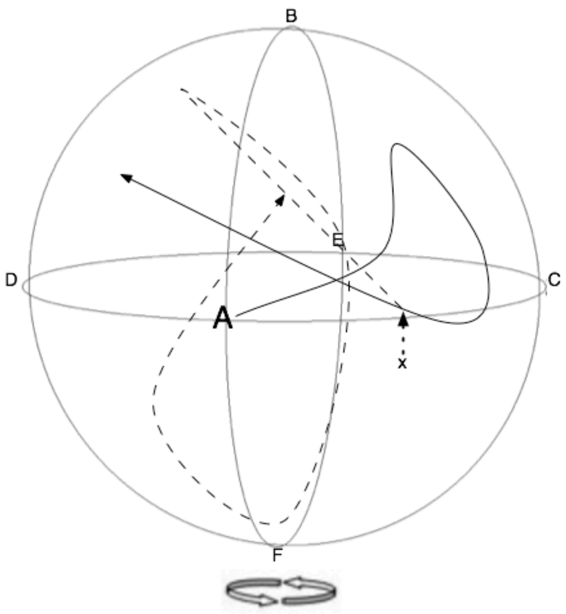

Figure 5.14: Abstraction of a journey through the personal space starting from a moment A with an alternative route imagined from influence x. The population of the inner sphere is abstracted here as it is seen irrelevant for this illustration what the actual concerns are, or whether they represent actual ideas.

Within these individual spheres the boundaries remain flexible and expandable. The perception of a noisy texture can become noisier by pushing the activity beyond the known concept of noise, like any indicative adjective (noisy) can be intensified with its comparative (noisier) and might reach a climax in its superlative (noisiest).

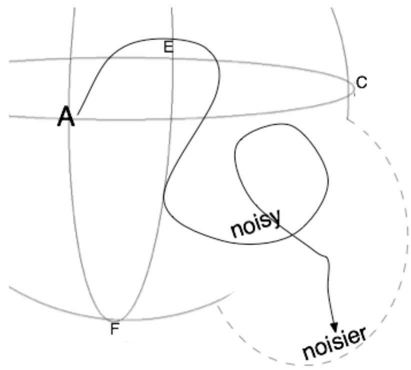

Figure 5.15: abstraction of pushing the boundaries of the known.

Within this description Agamben's 'reflexive form'[458] ought to be considered: Any comparative or even superlative state reached in the course of an activity becomes in our perception the new indicative through the expansion of experience and knowledge.

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458 Agamben 1999.

These models convincingly resemble the experience of events in our memory coming into focus and eventually disappearing from our sphere of attention again: not remembering a particular piece of information in a particular moment of time does not mean one has forgotten it, and the moment it returns to the foreground need not put it in relation to any chronological order in which one acquired this particular piece of information. Any hierarchies, associations, perceived timescales and inclinations in relation to these "items" mirror the individual's personality and motivation.

All musical experiences are therefore taken metaphorically as areas within the potentiality space. Heuristic musical activities are part of a permanent 'decoration of the interior' of the personality bubble of an individual. Any activity, whether it emerges intentionally or was found accidentally, can be seen as a note or picture placed in this "inner room", or to use Kuhl's terms, as placed in the EM. Individual experiences can emerge as a synthesis of several concurrent approaches. They may be 'reloaded' and subject to intentional serial processes in the IM. As this exchange is motivated by an increased negative affect, the perception of something unsuitable had to precede the exchange and triggered the wish to find further possibilities, variations and meanings within the musical context. As Dell states: "Improvisation [is in the] mode of permanent crisis. This crisis however ought not be overcome, but should be exploited."[459]

An initial insignificant discovery can develop into a more detailed picture through an increase in comprehension of the approach, its properties and results, much like a closer investigation discloses more detailed contours of its subject's parts. Continuing this metaphorical discourse, the picture can also reveal itself as a window indicating the existence of an entirely new space and eventually even open a doorway into it. Detailed areas can, however, blur over time, vanish or become concealed within other experiences, to re-emerge at any time as directly recognisable events or as being disguised within new perspectives.

During an improvisation one has the opportunity to focus on the existing interior of the personal and instrumental space. The movement through this combined space of possibilities corresponding with the act of actualisation of possibilities within the musical performance, can be preconceived, prepared and rehearsed. Such preconception

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[459] Dell 2002, 175: "Improvisation [... im] Modus der permanenten Krise. Diese Krise aber soll keineswegs bewältigt, sondern vielmehr genutzt werden."

and rehearsal would enable rapid change from one thought to another, it would facilitate fast and virtuosic presentation, and it might be perceived as an agile and graceful dance through the space of the (im-)possible.

This can be taken a step further by considering this experience and knowledge, the ideas and materials that one has placed in one's room, as objects that retain their potential for continuous development. A new idea is metaphorically attached to something, which reveals itself at a later stage as a much more detailed and complex construct and continues to unfold its further finesse in structure and texture.

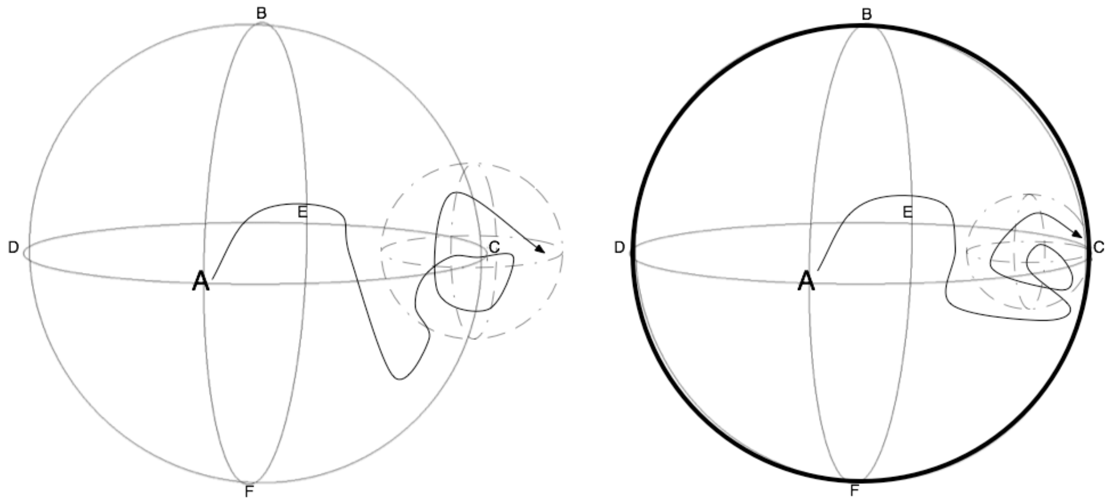

Figure 5.16: Heuristic process of discovering and exploring new space. In order to give a comparative illustration of the defined boundaries within the technology itself this figure indicates that without changes to the system itself such a heuristic process will be restricted by the unavoidable implemented limitation through value range, CPU limitations etc.

An idea can also be consciously discarded and pushed aside – as if deleted from the abstracted illustrations, or within the instrumental space a tool being put out of reach – then, almost forgotten, re-emerges and, when freed from the dust of time, be applied within different perspectives and approaches, to uncover a window, perhaps even a door, into spaces one had not imagined before (Figure 5.16). A simple iron bolt, as used by John Cage and employed by countless pianists after him as a means to augment the sonic potential of the piano, had always had the entire potential of use embedded in its material and form. Tilbury states in relation to this approach that "sometimes, a found object, possessed of a certain undefinable potential, would become part of the AMM inventory"[460]. The actualisations of the sounds however have to be wrenched out step by step to enter the consciousness of performers and listeners alike.

[460] Tilbury 2008, 298.

Chapter 6: The Practice of the Theory

The previous chapters have shown how aspects of the performance system have developed out of a symbiosis of personal interests spanning over technical, musical and philosophical topics. The realisation of an imagined aesthetic outcome was not the goal, but the development of a suitable environment to engage with technology, free improvisation inclusive wider social and political concerns. This chapter will use recordings of performances and studio sessions to indicate the practical relevance and value of the described performance practice. It remains difficult – even impossible – to pinpoint concrete music excerpts, because the underlying concepts and approaches are intrinsically embedded into the performance practice. Therefore, the evidence that thinking in potentialities and applying the metaphors of spaces creates different musical results can only be described according to existing actualisations. I have no comparative material available, because I cannot switch off the experiences and insights gained through this research. Looking back at available recordings of past performances[461], it is evident that it took considerable time until the development of the *piano+* and the approach to improvisation really came together. My personal impression was that a recording session in spring 2008 was pivotal: In those months I found the means to combine my research and practice to describe the envisaged performance practice; simultaneously the music became stronger and more convincing.

6.1. The Practical Conception and Background of *piano+*

While the intention was not to deliver a sociopolitical thesis, related concepts were an essential aspect and inspiration throughout the research. Similarly, my interests in the overwhelming variety of forms found in nature and acoustics, where the 'blueprints' of shape, size and behaviour only ever appear within contingent frameworks, influenced this research. The structure of a leaf enables the identification of a specific specimen, while each leaf shows unique variations. Music might have this property too: David Ilic's description of the music of AMM should be understood in this manner when he calls their music "as alike or unlike as trees"[462]. The organic quality of the music is

[461] A number of recordings from the past 10 years is available in the INTERLACE archive http://inter-lace.net .
[462] "With AMM, their albums are as alike or unalike as trees." David Ilic, The Wire, September 1991.

constituted of characteristics enabling the identification of the specific ensemble, while each performance is clearly distinguishable from another.

The diversity found in organic structures is alien to the technological world. Technology lends itself to the production of exact copies, which within the music can be seen most significantly through the production and distribution of recordings. Attali identified this as ‘repetition’, increasing the commodification of music and enhancing the expectation of exactly matching outcomes and standards of the musical product. Walter Benjamin identified even greater dangers within the technical reproduction: attributing a lack of “presence in time and space”[463] the reproduction “reactivates the object reproduced [... making ...] its social significance [...] inconceivable without its destructive, cathartic aspect, that is, the liquidation of the traditional value of cultural heritage.”[464] Although Walter Benjamin is concerned about film in his writing, his discussion can be applied to reproductions of sampled material within software technologies. Technology can facilitate elements which are ‘distant’ in time and space. They are too easily utilised outside their original context to be re-contextualised and embellished in superficial spectacles, satisfying the user’s wish to ‘access’, ‘do’, ‘create’ and ‘control’. Synthesis facilitates the creation of previously unheard sound textures, and manipulation through electroacoustic processes enable to render modulations until the source is unrecognisable. Such forms of ‘renewal’ appear as a means to embed material in new contexts, as well as to enable minute adjustments to suggest variation and contextual relevance. An ‘aesthetic of technology‘ – an “artistic gratification of a sense perception that has been changed by technology”[465] – promotes separation of the artistic from the human aspects – in its extremes reflecting the Futurist’s fascist exclamation: “fiat ars – pereat mundus”[466]. Even if the socio-political consequences are ignored at this stage, they indicate changes in human appreciation in order to compensate for the lack of variation in the technological process of reproduction. In fact, contingent elements are absent if not intentionally included into the reproduction. However, the human ear can discern minute deviations – or the absence thereof. This is in accordance with Kuhl’s

[463] Benjamin 1999, 214.
[464] Benjamin 1999, 215.
[465] Benjamin 1999, 235.
[466] Benjamin 1999, 235 Translation: Let art be created, let the world perish. (http://en.allexperts.com/q/Ancient-Languages-2210/Latin-English-4.htm) .

emphasis on the importance of the ORS[467] which forms a fundamental element of human behaviour and development. It does not surprise then, that the human ear is capable of detecting tiny changes in timbre in repetitive patterns or within a field of possibilities.

6.1.1. Synthesis Revisited in Aesthetic Terms

In aesthetic terms, the vast possibilities of synthesised sound production lack an inherently organic quality, although this can often go unnoticed by the listener if the sounds are not repeated or some degree of variation has been deliberately designed into them. This can be counteracted, as seen in particular attempts in sound design to create 'more real than life' versions of sonic events to enhance the perception and emotive responses, e.g. a field recording of a real explosion appears more convincing on film when perhaps various other sound elements such as filtered white noise, frying bacon, shattered glass and water splashes are mixed together[468]. This approach enhances the overall spectacle of the sonic event, and using these synthetic means, 'natural' sounds can also be alienated to suggest progress, create futuristic visions or abstractions highlighting aspects of human perception. While this shows parallels to the modernist approach within music concerned with new, previously unheard sounds[469], post-modernity potentially latches on the altered perception caused by unusual and unexpected combinations of sounds[470].

While the author appreciates many actualisations resulting from such approaches (e.g. Lely & White[471], Steve Beresford[472], Lehn & Schmickler[473], Helal Kebab Hut[474], etc.), there is a danger of working for the sake of superficial innovation. The need for new sounds can turn into an obsession for novelty, rather than an investigation of the potential of a sound, its variations, characteristics and potential organic qualities. The use of sound objects, electronic toys and gadgets including the use of lo-fi game sounds

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467 See Section 3.9.
468 Online discussions on sound design, personal experience in sound design.
469 This has its well documented origins in Futurism, the work by Henry Cowell and many others.
470 Sound track of Kill Bill, Quentin Tarantino, 2003, 2004.
471 John Lely and John White, for example recordings from INTERLACE 20.02.2005 also performance at the Freedom of the City Festival 04.05.2009.
472 Steve Beresford in performances uses electronics and objects, e.g. INTERLACE 01.04.2006.
473 Thomas Lehn and Marcus Schmickler: Navigation im Hypertext, CD released 2008 on A-Musik.
474 Recording from INTERLACE 14.10.2006.

show how technical gadgetry can slip into the comical. One might respond with amusement to perceive dislocated occurrences of sounds carrying established cultural references within such abstracted contexts. Sound production on such devices tends to be limited to very rudimentary binary controls: they are not supplying sufficient subtle control to be musical instruments. A performance is restricted to combine and place sounds within the structure and performance space. Although we can explore the combination of these sounds within convincing and compelling arrangements, the aspect of contingency within the sounds themselves is however minimised.

Harvey has outlined how technology impacts upon the compositional process, allowing composers to engage with sounds at first hand rather than trust in the interpretative process of human performance[475]. The impact of technology is "to secure the 'objectification' of [the European avant-garde composer's] composition" and free the "music of 'impurities' by minimising, ideally by eliminating, the indeterminacies which existed between notation and its realisation"[476]. A significant aspect is that even in acoustic works, computerised renderings can be employed to allow audition of the work-in-progress and perhaps to compensate for a lack of access to real performers. While this facilitates a democratisation of the musical engagement it has widespread consequences within the social and political spheres. To render music by technical means implies the use of technology to replace the acoustic, so the production of music can become a process independent from a social engagement. Synthesisers and sample techniques are often judged by their ability to convincingly imitate acoustic instruments rather than the new sound worlds they might enable. This is also the case with devices or software designing acoustic environments (reverb, diffusion systems). This offers a liberation from financial and space constraints, as, for example, a computer musician can then use the sounds of an expensive acoustic grand piano. But it equally entails a standardisation of the sound (demonstrated by the use of identifiable commercial piano sample libraries in pop productions[477]). This standardisation becomes most obvious in music notation programs which offer integrated sample players that attempt realistic playback of the notation. Standard markings (dynamics, articulation etc.) are interpreted by an automatic mapping to sample control, to render a convincing playback as long the

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[475] Harvey, in Emmerson *Language of Electroacoustic Music* (1986).
[476] Tilbury 2008, 295.
[477] I.e. the Korg M1 piano sound became a distinctive feature within Pop productions of the late 1980s and early 90s.

score restricts itself to conventional notation and techniques. As a result, experimental, – creative approaches to explore extended instrumental techniques – as well as novel approaches to notation are not included in these interpretative mappings. Such approaches are discouraged further, because of the technical proficiency required to implement complex or experimental notation suitable for a computerised audition of the composition. The development of workarounds (involving complex arrangements of different software, MIDI mappings and extended sample libraries) is an elaborate and time intensive activity in itself, which is both a distraction from the creative processes, and too restrictive to be a convincing rendering of the musical ideas. Whether intentional or not, such limitations through the use of technology have a significant political implication due to the unification of action and the restrictive channelling of the creative thinking.

The critique of rudimentary controls of electronic sound gadgets mentioned above extends to available software tools. Although this is not necessarily due to control restrictions in the software, real-time control – the possibility to use the software as an instrument – is often compromised by a hierarchical order of functions available in the main GUI or additional menus and windows[478]. No software tool can currently match the versatility of a physical object such as an acoustic instrument. A subversion of the initial purpose or function of objects, i.e. the utilisation of 'non-musical' objects as or in combination with musical instruments, creates new musical and sonic potential. Software cannot be subverted as easily. Data types cannot be easily exchanged[479] and 'translators'[480] require an elaborate mapping strategy to avoid being perceived as noise. It is possible to find musical potential within implemented software controls designed to enable specific editing processes or control. For example, the moveable playhead in ProTools 8[481], designed to assist to locate appropriate edit points in recordings, can be

[478] Software such as Ableton Live (http://www.ableton.com) and Mainstage (http://www.apple.com/logicstudio/mainstage/) have addressed this by offering customisable GUI options allowing the user to arrange parameter controls according to their individual work flow.

[479] E.g. using text or image files as audio source.

[480] E.g. tectonic project by Micah Frank http://micahfrank.com/post/422661719/finally-finished-the-prototype-for-tectonic-after.

[481] Avid Audio (http://www.avid.com/US/products/family/pro-tools) .

used in performance to allow brief playback of recorded material with the mouse reminiscent of a bowing gesture[482].

It might appear possible to contemplate extensive sample libraries containing all facets of sounds one could create on an instrument. Such an ultimate archive of an instrument's sonic potential – an immense quantity of actualisation – generates a demand to deal with quantitative storage and retrieval strategies, which prove themselves often counterproductive within performance: instead of producing an imagined suitable sound, one is required to searched for and retrieved a suitable sample. The musician working comfortably with such a vast array of source samples would need an acute memory for sounds and be able to select sounds to be placed according to characteristics appropriate to the musical context at any particular moment.

6.1.2. Aesthetics of *piano+*

The underlying aesthetic of the *piano+* has emerged as a consequence of the design of the system over time in combination with the extended techniques acquired. The electronic augmentation of the piano is part of the extended instrument, just as any other object might be used to produce acoustic sounds beyond the conventional piano sound. For instance, the use of the electronics might be compared to the use of a chopstick or any other percussive object that allows an array of extended techniques. But to describe the electronically augmented instrument only as a tool within the assortment of objects, has fundamental flaws, which are identified below.

The motivation of this approach is self-discipline: Despite the effort required to set up electronic equipment around the piano, the performer should not be tempted to use electronics just because it is available. Musical reasoning and suitability to the musical and social context of the performance should be the only qualifier. As stated in various presentations[483], it ought to be possible that the electronics are not employed, just as additional tools and preparations and particular keys and strings remain unused during a performance. This intuitive attitude to the chosen tools and instruments is personally

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482 Performance by Ian Stonehouse at INTERLACE 15.03.2003. This approach shows parallels to Laurie Anderson's Tape-Bow-Violin 1977 which uses strips of tape moved over a playhead of a tape-machine, techniques which essentially all derived from the tape delay (Holmes 2006, 299).

483 E.g. Seminar given at the UEA in Autumn 2006 and a talk as part of the ABA series at Goldsmiths 09.03.2011 http://vimeo.com/32670707 .

considered important, but I have to acknowledged that this claim has to be put in perspective to the specific characteristics of the electronics which complement my personal musical voice. The proposed performance practice has been influenced by the implemented electroacoustic processes, therefore the recordings of performances of recent years do not necessarily support this conceptional standpoint. It remains a consistent personal struggle to refrain from a standardised application but to search for new sonic potential in every approach. On reflection on past performances, one can suspect moments of reflective and internal conflicts about the 'musical appropriate' and 'do because one can do'. It would be too easy to summarise such an approach as simply 'being restrained', but there are intentional parallels to the restraint of "self-expression"[484] required in performance of works by Cardew, the detached approach to the musical material for repertoire by Cage, and the attitude to touch and sound required for Feldman. These aspects are furthermore informed through the interest into the strain of free improvisation described in Chapter 3, most consequently presented within the works of AMM. The focus to attend to the occurrences within the moment, space and place, and to absorb their full detail and complexity requires the previously described attentiveness, adaptability and spontaneity. Consequently the range of possibilities available through the electronic extension of the acoustic world ought to embrace its absence as well as its presence. As much as silence complements sound, the presence within an improvised ensemble ought to include silence as a positive contribution to the proceedings.

If electronic augmentation is considered equivalent to physical tools for sound production, it overlooks significant differences in sound characteristics. The tool (or "preparation") is a direct part of the activity that can alter the properties of the acoustic piano, such that the resulting sound is perceived differently to the conventional range of sounds produced by the hammer striking the string at the conventional place. Striking the piano string with another object alters the physicality of the point of contact at a different point in relation to the length of the string. The action of exiting the string can also be replaced: from a strike to a stroke, a rub or a scratch. At any moment an alteration to the physics of the sound production changes temporarily, as string length,

[484] Cardew: "Self-expression lapses too easily into mere documentation – 'I record that this is how I feel'. You should not be concerned with yourself beyond arranging a mode of life that makes it possible to remain on the line, balanced." (Cardew 2006, 132).

point and material of excitation are influenced. This is in some respect comparable to the way a piano technician would attend to the piano while tuning and adjusting its tone colour.

The electronics, on the other hand, manipulate the vibrations produced by the acoustic instrument, which were either captured through the air or as vibrations within its resonating body. 'Dipping'[485] and 'scrubbing'[486] are applicable performance metaphors[487], although 'indirect controllers' from audio analysis might disguise its application. The dependency on the acoustic source results in its continuous acoustic presence, whether desired or not[488]. This can only be eliminated through physical (and therefore acoustic) distance and isolation, or through a time displacement by delaying the signal momentarily (delays, short recording processes) or more permanently (through sampling). Croft's demand that "the response must be synchronous with the performer's action"[489] appears too narrowly defined, as with augmented instruments the immediate response would all the times be layered with the acoustic sound. But synchrony does not need to be as literal: One can witness through the acoustic complexities emerging in the decay of a piano note how the sympathetic resonances leave their imprint on the sound well after the note has been struck. In this manner, close temporal alignment between the acoustic and electronic can create a simplistic relation as it does not draw from the full potential of the 'mystique' of the machine[490]. The technology creates an ambiguity in our perception of the performance. It "exaggerates issues of personality, presence and performance"[491], as it can be closely related to the performers action.For example, when a ring modulator transforms a piano note into a complex bell-like event, compounding all the minute changes in timbre of its source. Alternatively, distance from the source event can be created by delays and prolonging the acoustic event (e.g. through granulation. Technological processes develop their own presence, enhancing but also subverting their source. Especially in the case of prolongation, the timbral qualities come to the fore which might otherwise

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485 Especially when controlling the volume of granulation.
486 Especially when controlling the position of granulation.
487 Described by Wessel 2002, see Section 1.4.1.
488 It has to be considered that the fascinating performance of Cage's Variation II by Tudor was recorded straight out of a mixing desk without the use of any air mics; as such the acoustic piano is absent from the recording.
489 Croft 2007, 64.
490 Zorn 2007, 193: Evan Parker quotes of "the myth of the machine" (1967) by Lewis Mumford.
491 Emmerson 2007, xv.

be masked. But most importantly, it is through these processes that the inherent discontinuity of the piano sound (in the sense that sonic events produced by the piano are time limited and therefore separated) can be countered: This is an essential part of the strategy to expand the sonic potential of this instrument.

Within the unavoidable presence of the acoustic source lies a difference which goes beyond the musical concerns. The acoustic source might be considered a disturbing element in the exploration of new sonic qualities as for instance in the recording of Cage's *Variation II.* An isolation of electronically modified sound was chosen by recording the electronic sounds directly from the mixing desk, eliminating the acoustic source. Within performance extreme isolation between the acoustic source and electronic modification can only be achieved through dislocation of performer and instrument from the sound-system projecting the sounds to the listener. Such separation is of significant social consequence, eliminating the performer's perception of the event. Responses and adaptations in relation to the local parameters of time and place are also compromised when it is attempted to mask the acoustic source through increased sound levels of the electronic part. Consideration of the correlation between source and technological possibilities is required to evaluate its consequences in the process of developing a humanised technology which avoids slipping into the spectacle. The qualities of humanised technology reach into the social and political spheres to enhance the overall potential emerging from co-existence and interaction of all its members and parts.

Within the socio-political realm, parallels can be seen in the displacement of integral parts of its sources, production and workforces in order to allow the isolated appreciation of glorified aspects and spectacles of political and social life. Finding techniques to allow the source to merge with its modification is a form of uniting with the past and tradition, not in structural forms (neither through content nor association) but through a fundamental reconsideration and readjustment of its use. Using Sloterdijk's and Wittgenstein's metaphor of the city, would such approaches not be required to be able to build a new city from the ground up incorporating the old as well as enabling the new, rather than creating a 'shiny' new quarter separated from the 'filth' which is fundamental to its own existence?

6.2. Performances and Studies

6.2.1. Studies

Notwithstanding the limitations of commercial synthesis and synthesisers identified above, at various stages of this research project it has been useful to deploy such tools. In the beginning of this project a synthesiser module was included in the setup as an alternative electronic resource to experiment with various processes (prior to software implementation) but also, in live performance, as a backup device in cases of computer failure. Several recordings of this work exist, and some indicate some evidence that these could potentially hold musical interest and go beyond the merely functional and exploratory purpose, if applied in different, non improvised, musical genres.

The purely electrocoustic study, 2007-01-23_electroStudy, was created using a Nord Micro Modular as the sound source. The processes used are granulation, resonant filter bank, and additive synthesis, as well as a sample library of piano sounds edited from studio sessions. This combination of materials and audio effects can be conceived as a ‘sonic sphere’: the processes are continuously running and appear to be audible within an ever changing relation to each other, despite the fact that the effects themselves quite often produce fairly static events. It appears that within the particular sound world of the source, the system produces a detectible range of processes which nevertheless show a degree of contingency because significant sound events from the source (piano library) change aspects of the system (processing). The audio excerpt Figure 6.1 shows the sonogram of minutes 2:56 - 3:20 and demonstrates how frequencies and amplitudes of sine tones are determined by FFT analysis to allow prominent partials of the source sound to be elongated until the process causes changes to this electroacoustic process. A synthesised looped pattern was used as the source material to ensure exact repetition of the material, in order to allow analysis and evaluation of the degrees of implemented or inherent contingencies in the electroacoustic process.

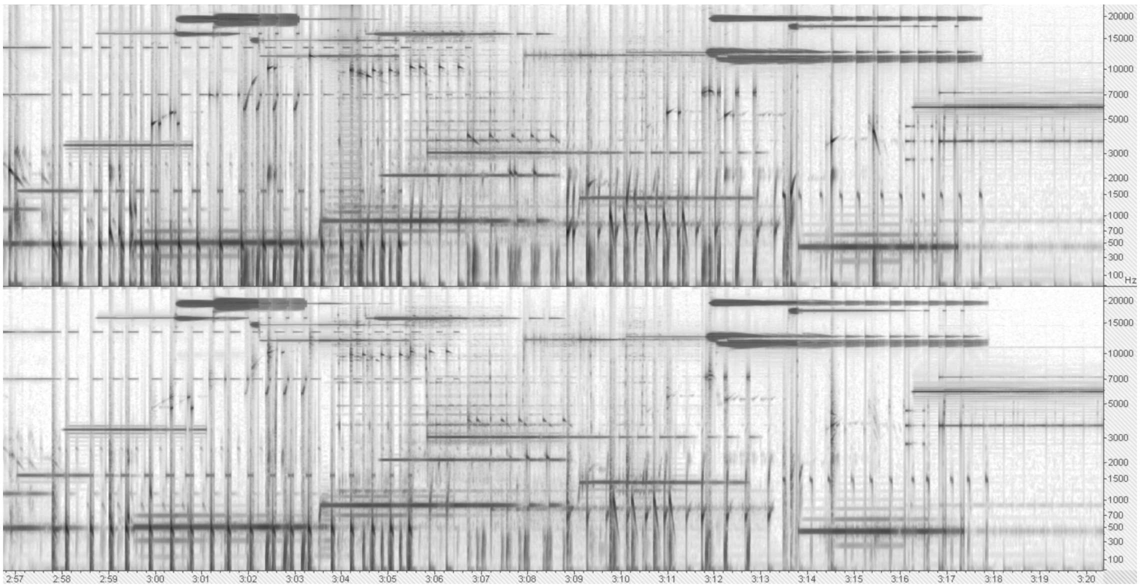

Figure 6.1: Sonogram of 2007-01-23_electroStudy_ex. All vertical lines are from the source, and granulator. horizontal lines are the elongated partials

The results shows that this process supplies contingent results: the elongated partials do not follow the loop exactly, but show sufficient relevance to the source material. These elongated tones can be seen in this visualisation of the audio excerpt (figure 6.1) as consistent frequencies (see horizontal lines above 500Hz). The result is, however, not a simple repetition: this is further diversified by the pulse inconsistencies due to the granulated fragments of an additional process. This sonic manipulation which has both consistency of material and variation in the audio process can be represented as a relationship between the vertical (y-axis, frequencies) and horizontal (x-axis, time). This relationship can thus be represented as a conceptual sphere of the material. The parameters used for controlling these functions outline a parameter space[492](e.g. y-axis: volume, x-axis: density, z-axis: transposition), ranging from 0% to 100% on each axis. In many ways this single space would suffice to plot countless 'positions' inside this sphere resulting from different ratios between the parameter values which control the sonic result. However, when moving away from discreet parameter descriptions and processes a similar approach is applied as in Chapter 2.3.1 and Chapter 4.6, where audio effects were considered as modulations of the vertical and horizontal acoustic properties. So it becomes clear that the effects themselves are reduced as a means for

492 See also the developments briefly described in Chapter 4.2.2 and Appendix IV Figures A18 - A20. Although these developments would allow the purest realisation of the spherical/space abstraction into the software control structures, the work was put on hold as the solutions were found too impractical and therefore considered slightly irrelevant to this thesis on performance practice. But further research is being considered in the future.

the actualisation within an instrumental space (in the example above essentially the electronic sphere alone). When using acoustic signals as inputs the source contains contingencies in the acoustic properties: even when one attempts to repeat the same pattern, the result would vary from one instance to another. The following example (audio example 2007-03-26_piano+cataRT_ex, visualised in figure 6.2) indicates how the data streams derived from analysis of an acoustic signal increase the perceived contingency without losing aspects of an underlying similarity. A piano note repeated three times (first three arrows in figure 6.2) causes granulated playback of pre-analysed recordings using Diemo Schwarz's CataRT[493]. What is audible as a sonic motif of waterdrops blending into bowed piano sounds is triggered due to similarities in the audio analysis data of each note. A repetition of an identical data stream would in this case cause exactly the same audio playback.

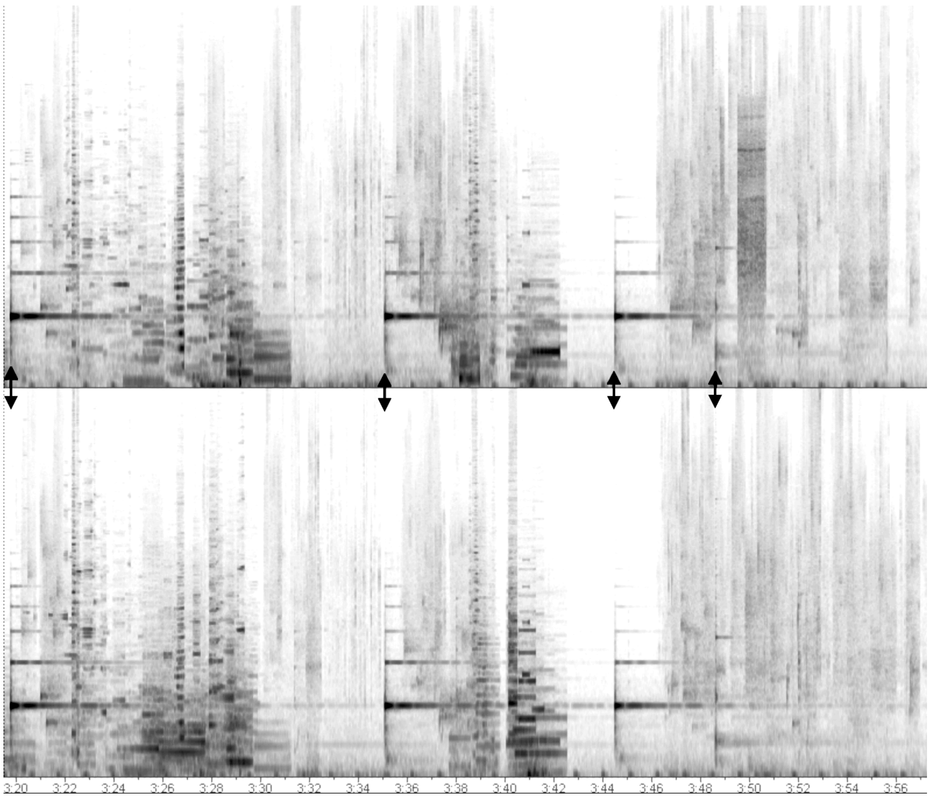

Figure 6.2: Sonogram of 2007-03-26_piano+cataRT_ex

The perceived similarities between this micro-sequence after the first three notes is significant: there is no randomness involved here, however, as the piano sound decays, the contingent development of the decay phase increases the likelihood of differences in the analysis, thus the course of the playback takes different routes. This deviation is

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[493] Real-Time Corpus-Based Concatenative Synthesis http://imtr.ircam.fr/imtr/CataRT .

visible in figure 6.2 at the point the performer plays a different sound (fourth arrow), which changes the playback drastically.

The relation between the sound source and its electroacoustic response becomes even more subtle when such data streams are mapped in a more complex way. Even a user familiar with the system may struggle to fully analyse and retrace the exact ways in which an action and sonic event are connected. But this has to be seen as one of the achievements of this research, as such subtle relationships were sought after, and constitute a strength of the performance system: The performer has, nevertheless, the chance to heuristically learn to utilise the possibilities of the processes within the musical activity. The performer can gain experience of how to provoke specific outcomes, while appreciating contingencies of its result.

As these examples were based on synthesised and sampled material, it might appear as a contradiction that synthesis and sample libraries are excluded from the performance system. But this indicates an important aspect of the research and development. Firstly, performance activity and the aims for the development of the instrument have to be clearly separated: The programming stages depend on the use of samples and synthesis, as this work cannot always be undertaken at the piano. Secondly, and more importantly: Since recorded and synthesised sounds can be repeated, they from the basis to evaluate the computer program design. It allows contingent behaviour of the electronic responses to be traced clearly in response to control data (see figure 6.1). When this relationship is reversed, by using processes which control the playback from sampled material (see figure 6.2), the contingency of the source affecting the processes can be perceived and evaluated.

This outlines a significant contribution of this research. Despite most of the implemented processes and parameter mapping strategies are well known and documented[494], a novel combination, suitable for free improvisation, is sought. Within performance itself and in particular in ensemble situations, the musical outcomes utilising samples is considered too rigid and predetermined. A prerecorded sound library can never constitute the sum of all actualisations of an acoustic instrument's sonic potential. It is through the performance activity that suitable characteristics of the sonic

[494] For references of granulation see Roads 1996 and Roads 2004, *CataRT* see for example Schwarz 2006, and parameter mapping has been documented in Hunt 2000, Wanderley 2000 etc.

quality comes into focus and is mapped out and realised. Within reflective music evaluation and analysis it could be assumed that coherence between the sounds emerges from a cohesive line of thought. Whether these follow a narrative and emotional discourse, or alternatively, display degrees of an analytical difference and variation of the sounds. Applying preexisting sounds in performance will face continuing difficulty to implement algorithms which enable practical, fast and effective sample retrieval that could deliver convincing – and artistically compelling – results. It is not solely through the qualities of the current sound that the next is decided upon. The influences can extend further into the past. And – remembering that improvisation is a physical activity – the position of the hand/arm or the physical proximity between gestures might actually have influenced the production of the next acoustic sound and musical direction far more than one might have ever imagined.

6.2.2. Performances – Solo

The combination of generative algorithms with sophisticated sound retrieval methods will probably remain of immense interest for a number of music, audio and commercial applications. But the simpler algorithms implemented in *piano+* (as described in Chapter 4) have shown novel musical potential within a real-time performance system in combination with a more investigative improvisation style. The implemented audio processes are not activated for specific musical and sonic situations but are constantly running with parameter adjustments occurring through a mixture of direct and indirect control. The live audio stream has its impact on the electroacoustic processes in two ways: The sounds are thrown into the processes while they also are a source to influence aspects of the manipulation applied to them. The performer invokes his/her control through the sonic material[495], as well as retaining the chance to utilise direct control, even if in the form of the most rudimentary decision as to whether the process is heard or not. These continuing processes create a discontinuity in the perception of the acoustic sound. The character of the *piano+* emerges not through the sonic augmentation in forms of accompaniment, but in the transformation of the acoustic. For instance, it may not be necessarily obvious that an acoustic sound is 'frozen' using a granulator, but it is more likely that this electroacoustic quality is perceived by gradually emerging out of the decay of the acoustic sound. The perception is therefore a

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[495] Video example excerpt 2009-10-30_LexerWright_pianoGranulation@Paris.mov .

subversion of the expected acoustic behaviour (Audio example: *Dazwischen*: *Time* minutes 5:00 - 6:59). This is not intended as a 'magic show': ambiguity is a fundamental feature, so that even the performer may be uncertain and held in suspense until an intended response occurs, or surprised when such a relationship emerges unexpectedly.

Within these qualities one can find the inherently pianistic qualities of this performance system. Modifications subvert the piano sound; the technology submerges into the acoustic instrument. This ambiguity can go so far that retrospective analysis of performance recordings is limited. It is not always possible to detect where the acoustic sounds have been superseded by the electronic continuation (Audio example: *Dazwischen*: *Rapprochement* minutes 2:15 - 6:30). The *piano+* positions itself on a fine line between deviation from the acoustic to embrace technology and subversion of the acoustic, subsumed by the technological. It exploits the ridge of a close relationship between extended instrumental technique and electroacoustic sounds; each can function as an inspiration for the other[496]. In this manner, the piano can immerse with the electronic part in two independent – yet intrinsically interwoven – ways: firstly, processes capable of retaining the piano character by subversion of the acoustic, secondly extended techniques which deviate from the conventional.

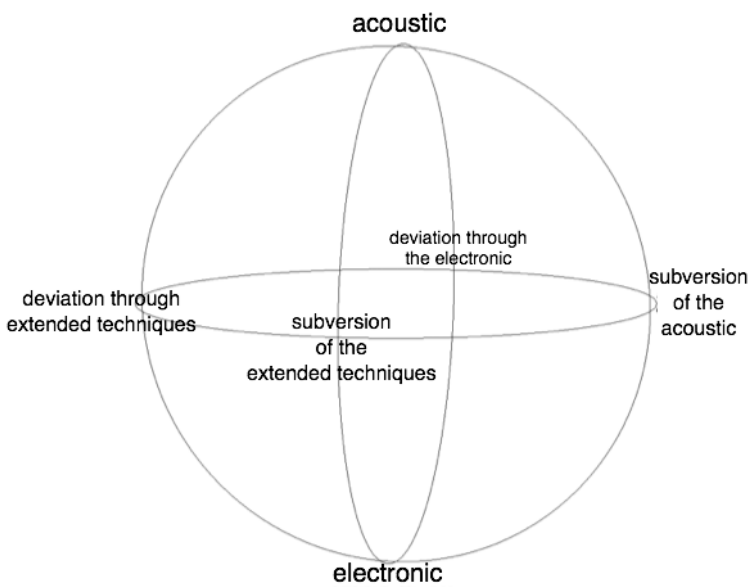

Figure 6.3: the augmented instrument in terms of subversion and deviation of the acoustic and electronic.

[496] Jürg Bariletti mentioned in conversations that he aims to create acoustic music inspired by electroacoustic sounds.

Performance outcomes can be plotted in the spherical abstraction in figure 6.3: any moment of a performance will occupy a position within this 'performance space'. The music emerges through the actualisation of instrumental and personal spheres, with their own musical characteristics that should be perceivable and identifiable for the listener. The performance is a sonic exploration of the space between the acoustic and the electronic in which the performer can engage in a heuristic investigation of the potentiality unfolding itself in between the poles of the spheres plotted. It is within this conceptual construction that the sessions released on *Dazwischen*[497] (the German word for 'in between') are each named according to an underlying focus during their performance. *Time* focuses on the horizontal axis and explores temporal dislocation of musical material within the processes that influence the improvisation through the repetitions and elongations activated by indirect controls. Within the first four minutes the interdependence between the acoustic playing and the electronic responses are clearly evident and indicate the recursive quality between the intentional acoustic direction and the adjustment of the musical activity to the resulting responses. More intentional activity becomes evident in the following three minutes, to steer the music in a different direction (this includes ring modulation and additive synthesis processes). From 6:58 onwards the performance focuses on the immanent modulation, climaxing in an elongated feedback that fluctuates between the acoustic conflicts (phase cancellation) of the feedback through the speakers and microphone and direct control of the tuning of the partials with a tilt sensor (Audio example: *Dazwischen*: *Time* minutes 7:00 - 9:07). This section is a prime example for the contingency that can emerge within the system. Although the result might be perceived very controlled and preplanned, it was only a coincidence that the feedback occurred with such intensity that enabled its sustain but allowed these minute modulations: Its simultaneous electronic reproduction through granulation revealed potential as an additional modulator for the delicate acoustic processes which influenced the proceedings significantly.

This piece is also an example of the importance attributed to listening during the performance. A goal-oriented, preconceived approach would have hindered such musical outcome, and any intention to recreate such a texture might be frustrated through the complex interdependencies within the system. The balance between

[497] Lexer 2009.

intentional direction and alertness to the actual events creates structure in the form of a heuristic dialogue. The balance between the 'self' – the performer – and the 'other' – in the case of solo performance, the instrumental and performance space – is in constant flux. Continuous adjustments are required to allow intentional direction and emerging opportunities of the potentiality space to 'harvest' the musical discourse. Within this dialogue a boldness to the proceedings is required to allow oneself to go a step beyond the haven of safety, without losing the connection to the moment, but with conscious avoidance of trapping oneself by remaining within the known.

Defining edges concentrates on vertical modification through filters exploring the acoustic in relation to clear electronic sound. It is a similar application of the process as discussed in Audio example 2007-01-23_electroStudy.wav. As described above, the non-repetitive and contingent nature of the acoustic performance creates a greater diversity of the resultant microstructures that grow out of the acoustic piano sound.

Rapprochement shows the opposite characteristic. The computer responses melt into the acoustic to form a sonic sculpture which often remains ambiguous as to where the acoustic stops and where the electronic starts (2:38 - 5:18).

My recordings prior to *Dazwischen* reveal the difficult balance between the intentional direction and adaptive response. Although the performances unfold within the organic evolution of the material, an often too cautious approach caused by the pursuit of preconceived notion of beautiful and compelling textures results in artificially prolonged and consequently disengaging sections. An exaggerated search for constant renewal endangers the emerging structures by changing too quickly, leaving only fleeting impressions which show that possibilities were overlooked and relationships were not explored. Musical structures are not necessarily achieved through temporal plans. It is proposed here that proportional relationships are more important: size, width, weight, and shape of musical textures and events that interrelate and impact the musical discourse[498]. This can be witnessed on *Dazwischen*. These attributes are not attached to the acoustic properties themselves. The loudness of a sound does not inevitably increase its weight within the texture; framing an event with silence can be much more effective.

[498] Brown's December 1952 and Cardew's Treatise have been influential for the personal realisation to consider structure to emerge from concerns about proportion rather than time arrangement.

Furthermore, interest emerges with controversies or even conflicts within the performance. The way a delicate texture is kept alive at the verge of breaking away, or moments at the threshold of uncontrollable chaos is what is considered fascinating here when performing. However, the spectacle of the display of skill to balance contingent elements is not important; rather it is the way one's situation and position is negotiated heuristically within the performance space. Mastering a situation on one occasion – i.e. contributing in a compelling and stimulating way – does not make it necessarily suitable for another situation. A repetition, or revisit, is only seen as a stage for further departure and negotiation, not for repeated appreciation and entertainment.

In this one finds the difference between the striving for mere novelty and the search to find new meanings and relations within one's own experience. This is neither modernistic, nor post-modern, but simultaneous reflection and projection of the present. It is an approach to performance that accepts musical actualisation as a result of complex human activity within its spaces, rather than design or the display of emotional states. Underlying narratives or emotional responses cannot be denied, since the activity is a result of one's personal spaces, but these are subjective elements, not intended to be conveyed in any explicit manner. Narratives might emerge through listening as a subjective journey through the discourse, resulting from active engagement with the music within the listener's own personal spaces. The space explored in between the acoustic and electronic reveals characteristics that can evoke a range of emotive responses.

There is possibly a form of violence against assumed outcomes which alienates the comfort of the expected in elementary ways. Although informed expectations might be made, according to individual experiences, a subversion of the acoustic undermines these. It is not the new unfamiliar sound of a synthesiser, it is the well established piano sound world which is subjected to scrutiny within every moment. It might be any note taking a turn towards the unexpected within its own sonic life, as if morphing into another. The beautifully compelling texture of a piano note might transform into screaming and piercing progressions. This characteristic is readily achieved by string, woodwind and brass instrumentalist, as for example a saxophonist is able to transform a sustained note by changes to embouchure and breath. Beyond the possibility to realise techniques available on other instruments, the subversion through the electronics indicates a more fundamental relationship of a hierarchical nature. Technology empowers through the means of amplification, repetition and potential autonomy from human control or decision through its own logic. Dusek cites Langdon Winner that the "consumer does not originate, maintain, or understand the complex technology or complex socio-technology of the system" and that all users involved with a technological system "lack overall intellectual grasp or strategic control of the system"[499]. Within the performance system *piano+*, a microcosm of the socio-technological has been established which attempts to counteract such shortcomings. It has been shown that the performer's ability to extend the personal musical voice by means of diversion and subversion are made possible by engaging with the instrumental potential. The instrument is not just the tool to facilitate personal expression but the means for personal engagement with the material to develop the personal voice within its potentiality space. This approach differs from the common description to become "one with the instrument"[500], in which the performer transcends the technical difficulties of mastering the instrument to allow the personal voice to emerge in its full expressive potential. What is described here is that the potential of the instrument is never thought to be transcended, but fully integrated into the creative process. The performer does not wish to go beyond the technical struggle and the conscious awareness of its materials, its surfaces, edges and gaps. S/he is neither subscribing to the content-based transformations offered by the electronics without retaining scrutiny of the musical results. It is in this area of intense and conscious engagement with the instrumental space where the full potential of electronically augmented performance practice merges with the human acoustic musical aspects. It is neither through the attempt to 'humanise' the technology to match human musicality nor by adjustment of personal interests and values that this symbiosis is achieved. It is not cyborgism "enhanc[ing] the human body toward a super-human ideas"[501]; it neither presumes an 'aesthetic of technology nor does it attempt to keep away from it. The interest to understand and implement the technology is retained, but the approach is not blinded by the technology, neither by its novelty nor by its spectacle. It facilitates the technological potential creatively without making the sophistication of the employed technological algorithms subject of the performance. Most importantly it attempts to understand the

[499] Dusek 2006, 108.
[500] E.g. Bill Evens (Tirro 1993, 415).
[501] Kreps 2007, 1.

social implications, it would not ignore warnings – including Walter Benjamin's convincing indication that technology facilitates Fascism[502], a view also strongly supported by Herbert Marcuse[503].

6.2.3. Performances – Ensemble

Blasen[504], a duo with saxophonist Seymour Wright, recorded in May 2008, had a key role in the formulation of this proposed performance practice. This long-lasting musical relationship cumulated in this recording session, during which it felt to me as if the conceptual research finally influenced the musical proceeding in a distinctly compelling way: a clear awareness of different spaces within the formed duo. The presence of different layers and roles of the material emerged interlacing with the personal spaces. In conversation after the recording session, both players indicated an awareness of an additional musical space augmenting the personal 'Blasen' (bubbles) which had significantly influenced the overall structural discourse and development of ideas. This space was actively and intuitively explored while the electronic part of the *piano+* both extended the sonic qualities of the piano and emerged as a semi-autonomous sphere located between the acoustic piano and the saxophone[505].

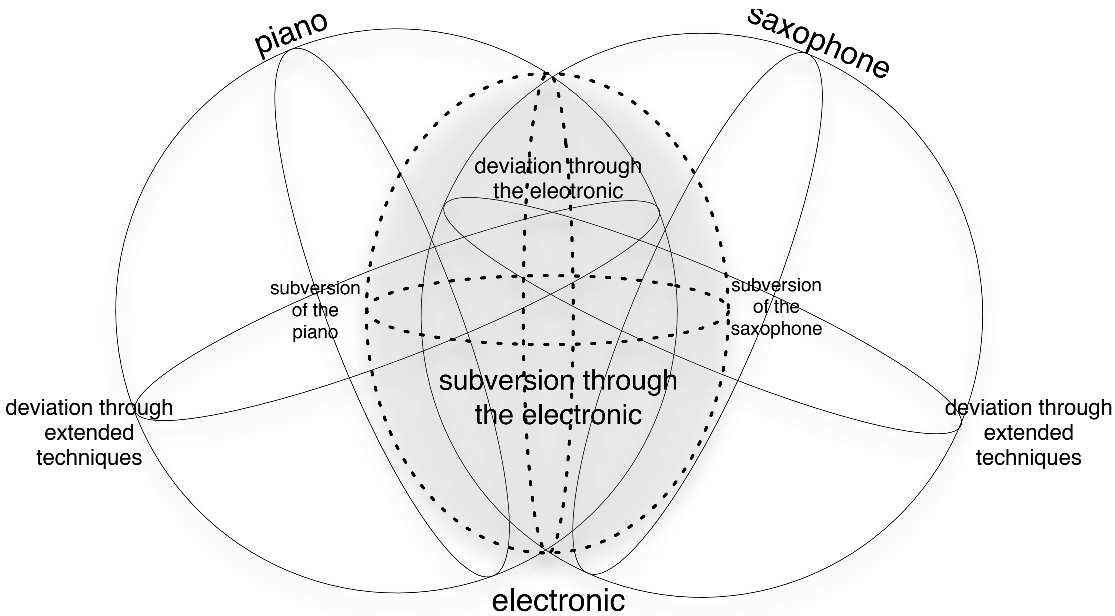

Figure 6.4: A semi-autonomous sphere emerging between the two instruments.

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502 Benjamin 1999, 234.
503 Marcuse 1982.
504 Lexer and Wright 2008.
505 Video example: 2009-10-30_LexerWright_sculpture.mov

The electronic extension establishes here a sonic identity between the two performers with more autonomy than a modulated acoustic sound. This is not perceived as an accompanying texture or additional functional voice like a third performer. The sonic construction follows the contingent controls of the pianist but also indirectly to the musical activity of the saxophonist due to the saxophone sounds bleeding into the microphones and the sympathetic resonances of the piano strings and resonance board[506]. The electronic part becomes a shared musical space within the interacting personal spheres. The structure of *Blasen* only emerges through the independence of the decisions of the players, their interaction and their response to the augmented texture recycling aspects of their own contributions. The musical awareness of Wright establishes an interactive approach with the electronic part, feeling that his contributions influence the electronics and that his choices of sounds can be decisive how the textures are created, maintained and destroyed. (*Blasen*: *Blase_25:34* minutes: 7:17 - 12:20).

The overall structure of the pieces appears as a loosely interwoven texture between the two players. Ideas emerge and develop quite independently and autonomously, while the intense listening and awareness of the musical situation does not equate in a synchronised discourse, but in cross-references to material and techniques that defy the progression of time. Despite an absence of direct controls for the saxophonist, the audio analysis enables sufficient influence to disturb the 'immunity' of the pianist as the *piano+* opens an additional shared space (*Blasen*: *Blase_25:34* minutes: 20:15 - end). However, in similar terms, the saxophonist's personal space is influenced too. The technology is not guiding him to fit into the processes of the electronics, but as he is part of the process, he will be influenced, in his own terms. The technology enables joint work on a sonic sculpture, differing from an approach to perform together. On listening to these recordings, the performance space appears established from the very beginning as if the space of the piece existed beforehand. The performers reveal its musical potential at their own pace, wandering through a sonic architectural space, just as cave explorers would shine light on the rock formations revealing different perspectives, constellations and connections. While the performers' activity unveils musical objects directly, the electronics work as reflections that alter the overall perspective as the unveiled continues to shimmer or emerges indirectly projected on other objects.

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[506] *Blase_25:34* has in particular an increased element of Wright's conscious interplay with this extended shared instrumental space.

The electronics therefore not only subverts the actual contributions of the players, but they have potential to re-contextualise their activity at every moment through the recurring perception of one's own contributions. The performers are faced with their own action, as if words in a conversation would reappear to amplify, influence, and divert them from their initial meaning.[507] The performance space is by no means a virtual space with virtual tools and characters, or a simulation to equip oneself with new instrumental and conversational skills. The structure of the music develops different than in an acoustic dialogue, because the electronics enters into the conversation. However, the electronic textures are not sufficiently distinct to suggest structures as they might emerge within a trio. Nevertheless, it is a musical reality that engages with technology without decimating human communication. The activity avoids fearful disengagement from contemporary concerns; full commitment is instead given to the evolving sounds and structure, to react responsibly to these ghostly trails of their identity within the proceedings. It is proposed that such a performance space gives a glimpse of reconciliation bridging the gulf between free and responsible human activity and "virtual fascism"[508].

Performances involving the *piano+* show that technology can be utilised while engaging with the sociopolitical situation encountered in performance. Despite my recognisable personal voice, a diversity of outcomes emerge within continuing musical relationships, as well as one-off musical encounters meeting players only minutes before the start of the performance. It is considered a crucial part of the practice that performances are not prepared and rehearsed in any way, mostly even avoiding a shared sound-check. This is not to exclude continuing musical relationships[509]. Possible differences in musical approach are carried out on stage. A degree of trust is necessary, especially if one knows the fellow player usually engages in a style of improvisation that makes the pairing appear an unlikely combination.

A significant personal experience was a recent duo with the drummer Steve Noble[510], who engages in strikingly energetic performances[511] and therefore occupies a musical

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[507] Video example exceprt 2009-10-30_LexerWright_granulationInteraction@Paris.mov .
[508] Kroker 2004, 41.
[509] E.g. Seymour Wright, Eddie Prévost, Paul Abbott, Grundik Kasyansky, and since December 2009 Christoph Schiller.
[510] Performance at Muddy Ditch #2 Cafe Oto 25.10.2011. Audio Example: 2011-10-25_LexerNoble.wav .
[511] http://www.efi.group.shef.ac.uk/musician/mnoble.html (last visited 20.07.2012).

space I personally do only on rare occasions because the quality of the *piano+* lies in more subtle processes. The performance felt like a test for the concept of the *piano+*: Being able to engage in the performance to find the space between our personal approaches: on one side the exploration of contingencies, yet on the other hand allowing energies to flow with the more rhythmical percussive encounters. The concert felt most satisfying, and the recording confirmed the feeling during the performance, not solely by the complexities in texture, nor because the balance between the acoustic spaces became mediated within a shared electroacoustic space. It's success in relation to this research is that it has confirmed that the proposed performance practice is capable of being applied in musical situations without any sociopolitical or interpersonal aspects being compromised to make the technology fit into the musical discourse. The first minute of the performance (Audio Example: 2011-10-25_LexerNoble.wav[512]) establishes the ground: In some respect the overall sonic relationship is sketched out. The tentative, yet energetic, gestures are enough to establish a space in between the two players and clarify how the system can augment and interfere with both. While around minute 2:30 the piano is the main contributor for the static textures, the seconds leading up to minute 3:55 shows a surprisingly clear imprint of the drums.

Although the performance could be described in further detail, indicating different degrees of interaction between the players and the technology, an analysis remains almost irrelevant. It is the personal attitude and approach to social, political and ethical topics that allows a musical conversation freed from pre-established or emerging hierarchies. The constantly evolving nature of the improvisation and the acceptance of the temporality of every single sound event enhance the awareness of one's contribution and how it affects the proceeding. One is required to take a responsible stance and cannot shy away from pushing – or being pushed – into the unknown. This performance felt successful, because it appeared that the performance had found the real middle ground between the players, including energetic drumming and the most fragile textures (e.g. minute 22:05 - end).

Considering other performances, for example, the duo with Ute Kanngiesser on Cello (Audio Example: 2011-10-25_KanngiesserLexer_25-10-11.mp3), which remained completely in the acoustic realm, the duo with Aleks Kolkowski (Audio Example:

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[512] The mix is consciously favouring the electronic tracks.

2011-07-02_Kolkowski_Lexer_Whitstable_ex.wav), which saw the *piano+* used in combination with the Church Organ in St Peters, Whitstable, and the duo with Christoph Schiller on Spinet (Audio Example: 2011-03-06_SchillerLexer_AAAT2011.mp3), the flexibility of the system and the applied performance practice is evident. It shows that the technology has been adapted according to the sociopolitical understanding of the activity which suspends expectations and unlocks the potentiality spheres. The actualisation of the performance is therefore not hindered in the moment to engage in "thinking a thought" and "thinking of a potentiality"[513]. This approach is facilitated for concrete practical application by the proposed theoretical method of the spheres adding a flexible procedure to heuristic inquisitive approach to improvisation. It is my conviction that it has increased my creativeness to find the suitable music to react, respond, adapt, guide and follow the musical moments I encounter.

Responsible action and acute awareness of the potentiality of the situation enables actualisations within sociopolitical musical constellations which cannot be preplanned nor repeated. Listening to recordings of these events is useful nevertheless, as the detachment from the performance activity itself reveals aspects which might inform the attitude and approach for future performances. For example, the perception and evaluation of duration differs greatly between the playing and listening experience. Recordings have been helpful to learn from the experience from a different perspective: Realising that one has the tendency to move quickly from certain textures and linger on others, in other words, whether the conceptual spheres are rotating too fast or too slow, or whether the journey through these spaces is hastened or dragging. Furthermore, potential patterns might be detected and alternative routes might be imagined. Every situation is attempted to be sensed in as many aspects as one can possibly grasp. Such attempted responsibility to the performance activity requires a technology which when applied facilitates the open approach to explore its potential without unifying limitations and without oppressive qualities restricting other personal spheres.

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513 Agamben 1999, 250.

Conclusion

This thesis presents a holistic approach to researching and theorising a performance practice which engages with new technologies within free improvisation. The personal concerns regarding improvisation, instrument and technology form three fundamental areas which intrinsically correlate within the investigative practice. The instrument facilitates the conceptual approach and the activity empirically informs the demand on the instrument. The design of interactive music instruments requires specialised research into suitable technology. Such specialism might, however, deflect from artistic value and purpose within the practice. Conceptual and philosophical insights inspired the theoretical investigation of improvisation and have a continuing impact on the practice and technological developments.

The presented performance practice involves the performance system *piano+* and is the result of a reflexive approach to deal with these interdependencies. It is proposed that the field of free improvisation, in which the potential of musical activity is investigated and scrutinised within the activity itself, allows a consistent exploration of its instruments and approaches. It is not assumed that the context of an improvisation will adapt to include the instruments employed, but that it is possible to ensure that instruments are created supply the appropriate means to adapt one's activity to the situation in the sociopolitical context. The realtime electroacoustic processes researched, implemented and applied are of considerable technical sophistication and utilise – and expand on – current research in interactive technology, audio analysis and parameter mapping. The processes are related to the performance and philosophical concept through the approach of their application, rather than in the form of sonic modulation and content.

The concept of the *piano+* emerged in direct relation to the tradition of the piano, its parts were researched and gradually implemented while being continuously employed at the piano. The *piano+* is not an electroacoustic concept involving the acoustic piano, it emerged as a result of gradual and continuous exploration, for which electroacoustic techniques are a substantial means to expand its potential. The sonic potential and contingencies of the acoustic piano, expanded by the use of extended techniques, is further augmented by electroacoustic processes to subvert and divert the acoustic properties of the piano.

A philosophical abstraction in form of the metaphor of personal spaces unifies these techniques. These spaces are not fixed entities, although particular abstractions can come close to an objectification, for example the potential of the instrument can be cohesively mapped out. They are a means to abstract the relation of the self to the other. This dichotomy is not grounded in the physicality of objects but in relation to the perception and perspective of oneself, one's tools, the musical and sociopolitical context and environment. This facilitates individual development of one's own understanding of the relationship to the entities around to strengthen the creative approach within the diverse possibilities.

John Tilbury, my former piano professor and mentor, expressed the following in relation to my CD *Dazwischen*[514]:

> Perhaps the (acoustic) piano cannot survive. Certainly in its 19th century incarnation it is threatened by obsolescence, overtaken by a confident, predatory new technology. (New venues boast state-of-the-art electronic, computerized pianos, but rarely a Steinway, or a Bösendorfer).
>
> Samuel Beckett prophesied its demise in Watt:
> "The piano is doomed, in my opinion, said the younger.
> The piano-tuner also, said the elder.
> The pianist also, said the younger."
> I no longer share Beckett's gloomy prognosis.[515]

Receiving these words as a response to my music from a person I hold the highest respect for, has been most encouraging as evidence that my concerns present in the theoretical research found their voice in the artistic and practical outcome. Tilbury describes new technology as "confident" and "predatory", roles it frequently and comfortably inhabits within music and the arts. The piano itself, mechanical technology representing the bourgeois tradition perhaps more than any other instrument, is "doomed" and "threatened by obsolescence" as society embraces digital technology capable of facilitating widespread access to the most perfect and pristine imitation through recordings and sample players. The technology enabling the distribution of flawless copies of music and art threatens its own sources. This is partly caused by the successive commodification of music and art, but also because digital art only exists in

[514] Lexer 2009.
[515] Tilbury in Lexer 2009.

its own reproduction. By itself, technology is neither good nor bad: the destructive capabilities of technology cannot be blamed on technology alone. Human beings, capable of considering the consequences of their actions, can find responsible functions and roles for technology. The past 100 years indicate how technology has facilitated incredible advances in tandem with unimaginable destruction linking technology intrinsically to imperialistic and fascist political movements. Political systems might base their expansionist exploitation on technological dominance and surveillance; others might herald technology as a messianic means to democratise and free the world[516]. In either case, technology influences human life and interaction and it has entered most aspects of modern life.

My personal dilemma, expressed in artistic terms within the music and as the underlying current within this research, is to find an acceptable borderline between technological advance and social compatibility and tolerance. This is reflected in the implemented sophisticated electroacoustic processes and interactive technology that allows one to overcome limitations of commercial software tools. A proficiency in the use of technology facilitated the means of creating an instrument while remaining an improvising musician. This is in some respects a privileged position to be in: being able to create one's own instrument to reflect personal musical interests.

The performance practice emerged from the application of the *piano+* system. The title of this thesis hints at the potential incompatibility between live electronics and performance by adding a second 'live' in front of performance: as if a truly live performance cannot necessarily be expected from an application of live electronics. Live electronics, by definition, facilitates real-time interaction with musical processes, but a consistent concern with aspects of live performance requires the ability to react to every aspect of the performance *in situ*. Live electronics in live performance demands the electronic sound to be created in the moment of the activity. It has to be an intrinsic part of the instrument to allow the adaptive quality and flexibility to suit improvised performance. It is neither sufficient to consider it as an element to create musical structure nor is it – in the context of improvised music – enough to be "'playing' [...] the

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[516] Attali 1986, Benjamin 1999, Marcuse 1998, Sloterdijk 1998, 1999, 2004.

soundscape as instrument [...] presented as reaffirmations of life and 'live indicators' in music"[517].

The intrinsic relationship between the technology and the musical potential was established from a historical and technological overview of electronic instruments to draw attention to the demands for new sonic sources facilitating progress and reflecting changes in society. Wessel's metaphors for musical control[518] and Croft's performance characteristics and conditions for instrumentality[519] added useful metaphors and characteristics to describe the role of interaction between performers and electronic instruments. Overall we can conclude that the diversity of approaches and technology yields immense potential unique to technology (i.e. sound sculpturing). However, the importance of a contingent element within musical control has been highlighted in order to extend the general sonic flexibility with the potential for instantaneous adaptations and adjustments required for improvisation.

Simplifying the concept of electroacoustic processes – reducing it to the manipulation of timbre, time and locality – is instrumental to focus on two distinct types of activities: operational activity to prepare and adjust processes and performative activity that has immediate audible results. Parameter mapping is fundamental in relation to the design of control structures, however, a distinction between direct and indirect controllers enables further discussion on the means to reduce operational activity within interactive performance systems. These topics are combined in a conceptual instrumental space. Its architecture and the means to operate within it have direct implications on the performativity and musical potential. This exposes a dilemma of whether musical problems encountered could be corrected by implementing changes to the instrument design, or whether further musical engagement ought to be invested in the current stage of development to explore the instrument's potential. It has proven occasionally difficult to balance time and effort between instrument development and practical application. The deliberate interruption of further instrumental developments created the space to learn the potential and idiosyncrasies of the instrument. This heuristic investigation of the instrumental potential in solo and ensemble playing served as a basis to learn the

[517] Emmerson 2007, 60.
[518] Wessel 2002.
[519] Croft 2007.

capabilities of the *piano+* beyond any initial conceptions and enabled the technological approach to mature.

The metaphor of an onion is used to describe the *piano+* with the acoustic grand piano as its core, augmented by layers of extended techniques using the interior of the piano and preparations and electroacoustic processes applied in real-time. This analogy to a spherical object appeared even more appropriate considering the application of the spherical abstractions inspired by Sloterdijk's philosophy: The physicality of the instrument and its parts are conceptualised as potential available in the instrumental space. An exchange between the layers is possible on conceptual, mental, acoustic and physical levels.

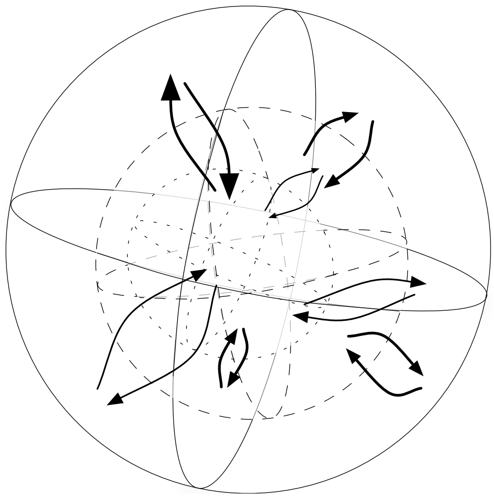

Figure C.1: The *piano+*, instrumental space with the acoustic piano as a core, inner layer of extended techniques and electroacoustic processes as the outer layer. The indicated exchange ranges from actual physical exchange of sound via microphones, acoustic feedback (e.g. sympathetic resonances) but also theoretical and mental influences and dependencies.

The sounds from the piano and extended techniques captured through a variety of microphones are routable to the selection of electroacoustic processes[520]. The flexible and adaptive control structure of the proposed triple controller system, a combination of direct and indirect controllers from a mixture of MIDI and touch surface controls, sensors and audio analysis, enables sophisticated parameter mapping capable of showing contingent qualities within the parameter space. The contingent control, an important feature connecting the different layers aesthetically, is attributed to the utilisation of continuous data streams from indirect controllers. The proposed technological methods give an improved feel to the controls of the electroacoustic processes which can be explored through heuristic investigative activity. A scrutiny of

520 Granulation, filters and pitch modulations.

an 'aesthetic of technology' indicates that – evaluated in the context of the proposed performance practice – the properties of synthesis and sampling do not allow sufficient contingent behaviour to be considered a viable option. The implementation of alternative, more sophisticated, technological means for intuitive control of sampled and analysed material within a sonic continuum has not been followed through consequently within this research. Although it has been realised that there is considerable technological and artistic potential of available approaches, the practicalities of the current implementation of the triple controller system has enabled operational tasks to be kept to a minimum by shifting the control of the system to the acoustic part of the performance (audio analysis) and gestural information (sensors). As a result the electroacoustic processes are controlled by the acoustic sound or performance gestures. A discussion and characterisation of extended techniques, investigating a range of approaches and methods facilitated an overview, focuses on gestural considerations. This shows that adopting and adjusting aspects of the playing gestures might also produce musical coherence even though the performer might not select the methods from sonic considerations. Such approaches developed from a focus on heuristic and investigative approaches where insights were drawn from the discussion of improvisation in general, and have been significant for the technical implementation.

Widening the perspective, to include the performer's personal space, the relevance to Sloterdijk's philosophy of the spheres becomes more apparent. The instrumental potential is part of the performer's inner space as the inventory facilitating the performer's musical activity during performance as a journey through the space. Utilising the initial distinction between idiomatic and non-idiomatic improvisation[521] and a differentiation between cognitive processes[522], the definition of free improvisation as an investigative and heuristic musical activity[523] is strengthened.

[521] Bailey 1993.
[522] Kuhl 2001.
[523] Prévost 1995, 2001.

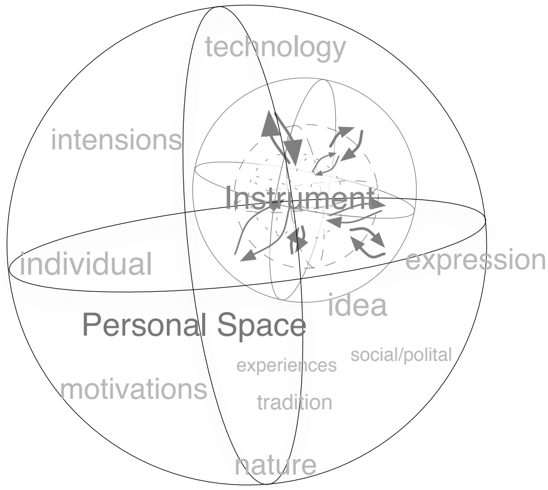

Figure C.2: The instrumental space as inventory of the performer's personal space. The size and placement and spacing are only for graphical representation. These conceptual 'spaces' are fluid and in constant flux.

Memory works intrinsically non-linearly, accessing thoughts from holistic experiences (total knowledge[524]), detached but capable of specific investigative activity[525]. These insights highlight the reflexive nature of learning and expose the reductionist improvisation models[526] as insufficient. In other words, the development of the personal voice within the potentialities of the situations depends on continuous investigative engagement. Thinking about the potential – in terms of instrumental inventory and personal approach, which is a useful extension of the spatial abstraction – is grounded in Agamben's theoretical work. It also gives the philosophical ground to argue for responsible individual activity, rather than referring to objective and absolute goals and concepts. Agamben shows that the idea of the 'Absolute' (Hegel) has been absolved from the individual – hence it is considered the objective – but that it is the 'Event' ('Ereignis', Heidegger) that has a "finitude in itself"[527]. This conclusive comprehension and acceptance of its own occurrence enables the freedom to take full advantage of the potential of the activity. It retains an awareness of the possible alternatives and allows the actualisation of the audible result (the performance) to be what it is, insofar as it is possible to accept what it has not been able to be. In fact, Agamben shows that the potentiality is defined in terms of what has not been actualised. It is the awareness of potential that facilitates an investigative activity that is essential to the ongoing processes of learning. The potential of the moment also highlights the

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[524] Dell 2002.
[525] Kuhl 2001, Intention Memory (IM)/Object Recognition System (ORS).
[526] Pressing in Sloboda 1988, Sarath 1996.
[527] Agamben 1999, 129.

importance of the social situation: it is neither restricted to the self, nor is it necessarily defined in predetermined functional relationships between musicians. It is therefore argued that free improvisation extends the investigative approach into all aspects of the musical activity, including the continuous scrutiny of one's own actions.

Sloterdijk's philosophical discourse[528] influenced the approach to improvisation. When performances are seen as momentary realisations, the potential and individual processes involved in experiencing and learning can be described through the spherical metaphor. This provides a means to conceptualise all aspects: learning, heuristic activities, practice, education, tradition and culture. The "bubble", the personal inner space, contains all the physical and mental potential constituted in the knowledge of instrument, material, sound, and technical skill, and is combined with the all-encompassing experiences, motivations, and intentions of the individual, including the sociopolitical stance and beliefs.

Learning and acquiring experiences becomes a metaphorical equipping of one's 'inner space' (Innenraum) that enables one to consider selections of concerns and interests as areas and poles within the spherical abstraction. Such spherical conceptual abstractions can reflect one's personality; others might reflect more specific areas of interest. It was shown how, for instance, my personal space describing the wider interests in music, encompasses more specific instrument and music-related spheres, a part of which can be abstracted as outlining the electronic software design. While the arrangements of concerns populated in spherical abstractions might be fixed, their focus can change through a conceptual rotation of the sphere. However, changes over time are possible and likely when the performer is engaged in a heuristic and investigative activity. This facilitates the differentiation between the actualisation of the sonically perceivable performance and changes in perception and evaluation that might occur during this activity. Changes in the physical activity are not necessarily simultaneous to the cognitive process reflecting changing focus and importance. A development of Sarath's concept of 'projected possibilities' and the 'alternative realised'[529] in the context of non-linearity in thought has resulted in a model which considers ideas as possible paths through the spherical abstractions, whereby the actualised performance is the conceptual

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[528] Sloterdijk 1998, 1999, 2004.
[529] Sarath 1999.

journey. While the actualisation might remain within a specific area of concern (the musical activity remains similar) the perception of it might change significantly (rotation of the spheres). Within these changes new ideas can form as different concerns and constellations come in and out of focus.

It is shown that this model of rotating spheres can successfully be applied to all aspects of personal, musical, instrumental and technical concerns. It is therefore also proposed that this model has a more general validity for creative work. The unifying metaphor supports the notion of an interdependence of the 'total knowledge' in performance activity. It relates the performance approach to a wider sphere of socio-political concerns. Sloterdijk's philosophical discourse shows that interpersonal relationships are a continuous struggle between an urge for infinity and a need for immunity. This is a conflicting attitude towards introverted personal security and outward expansion of one's own sphere of influence that causes tension and social dissonance, even within musical micro-social situations and interaction with one's instrument. The feeling of affinity and unity – to be connected, close and in control – also suggests the existence of resistance, in the form of problems and frictions that emerge within the context. These conflicts are often addressed by introducing deliberate, preconceived rules to impose specific behaviour (e.g. notation), rather than allowing processes "to trace connections *between* the controversies themselves"[530]. The interest in performance can be found within the evolving and emerging means of tackling the problems and frictions between the self and the other, whether the other is an instrumental potential or a sociopolitical constellation. As Dell states: "Improvisation [is in the] mode of permanent crisis. This crisis however ought not be overcome, but should be exploited."[531] However, the description of crisis extends to an entire continuum spanning from investigative approaches, problem solving to real conflicts.

Software design lends itself to unifying modes of creativity that induce a notion of continuous development despite only relying on superficial changes in features as a means of progress. This perpetuates the glorification of the technological product, rather than encouraging responsible exploration and scrutiny of these as mere tools.

530 Latour 2005, 23.
531 Dell 2002, 175.

Contingency, and its approximation in technical terms, is established as key to the aesthetic approach to the *piano+*. The technology is not intended to increase the 'magic' of the performance spectacle, nor is it considered as an extension of the expressive repertoire for a narrative to be transmitted by the performer. The aesthetic stance is to detach oneself from emotional self-expression, the performance being offered for its potential for attentive listening. The potential presence of performer, acoustic sound and its electroacoustic augmentation, also includes their absence and silence. It is the listeners' chance to engage, listen and scrutinise according to their own personal spaces, to distil their relation to the emerging spaces between the established acoustic tradition and its electroacoustic diversion and subversion.

The *piano+* has become an instrument incorporating my personal interests, facilitating a performance practice which is highly individual and integral, not because of any individualistic or unique expressiveness, but through an informed, yet experimental and investigative approach to unlocking the potential of the musical moment. The developed technology has become submerged in the acoustic instrument, not by diffidence or submission, but by the means to incorporate and emerge out of the acoustic complexities of the piano's decay phase or embellishment of the attack. These modifications result in a subversion of the piano sound and create an ambiguity between the acoustic and electroacoustic, which, in artistic terms, relates to the unease of my own fascination with the technically enhanced while remaining overwhelmed by the extraordinary contingencies one can find in nature. The piano is not augmented in terms of additions attempting to find "poetic relation"[532] in sonic events or their arrangement in constellations and coherently presented narrations. A relationship is sought which is grounded in the quality of the instrument and its application to social situations. The symbiosis of the acoustic and electroacoustic spaces unlocks a potential, opening a poetry of subversion and deviation. This entails the qualities of gradients and continuums filling the spaces in between defined positions and poles. Subversion and deviation also delineate extremes, which stretch from nearly unrecognisable caricatures and mutations of the acoustic instrument to the thresholds of audibility and noise.

Marcuse's assertion (quoted in the introduction) that technology can "promote authoritarianism as well as liberty, scarcity as well as abundance, the extension as well

[532] Croft 2007, 59.

as the abolition of toil"[533] has not been devalued, instead the performance outcomes confirm that the dichotomies might be moved into a healthy and responsible mixture during performance without being conformed and regulated by means of preselections in content and methods. Instead the investigative activity explores the entire performance situation, giving respect and space to the potentiality of every element, whether they arise from sociopolitical and individualistic positions, interpersonal and personal concerns, or investigations about instrument and substance.

This performance practice has been applied extensively throughout the period of this research and the performances show a diversity in the music with a wide range of musicians. The improvisations have been as diverse as the events, nevertheless the *piano+* has given me a personal, even a unique, voice to engage with a range of musicians[534]. Each moment has provoked situations where each person's experience – each personal space – has contributed to a further investigation of the potential of the moment. It is reassuring that if one "exist[s] in the mode of potentiality [one is] capable of [one's] own impotentiality"[535] which in turn defines potentiality. It is through this concern that the performance practice around the *piano+* retains a fundamental pianism. It neither negates its root, nor does it commit to an interface that ignores the contingencies found in acoustic sound. It appears that through the extensive exploration of extended techniques, a mediating layer has been found which reconciles the intrinsic differences between the acoustic and the technological. Extended techniques open up the 'poetic' space to divert from the conventional, while the electroacoustic subverts possible meanings. In an age in which amazing technology has been perfected for inexhaustible repetition, it becomes an art to divert from simplistic and dull repetitions without negating its possibilities.

In the attempt to find a membrane marking the difference between the one and the other, it appears that one could only find a space embracing both, without being either. Perhaps the entire research and its resulting performance practice have been about being "dazwischen" – in between.

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533 Marcuse 1982, p. 139.

534 For example, Pascal Battus, Frédéric Blondy, Jamie Coleman, Ute Kanngieser, Grundik Kasyansky, Ross Lambert, Steve Noble, Eddie Prévost, Keith Rowe, Christoph Schiller, Marcus Schmickler, John Tilbury, Michael Vorfeld and Seymour Wright. See Appendix II – Performers for a comprehensive listing of the period from 2004 - 2012.

535 Agamben 1999, 183.

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Appendix I – Performances

performances 2004 - 2011 chronological order starting with the most recent
see http://sebastianlexer.eu/project/performances/

Concert recordings included in the submission have been marked in bolt Audio or Video example and the file name as included on the DVD

All INTERLACE sets listed below are accessible as mp3s on http://inter-lace.net

18.12.2011 Eddie Prévost's 'The First Concert – An Adaptive Appraisal of a Meta Music' Book launch and concert.
Hutch Demouilpied (trumpet), Grundik Kasyansky (electronics), Sebastian Lexer (piano+) & Tom Soloveitzik (tenor saxophone)
Cafe Oto, Dalston Junction, London

03.12.2011 INTERLACE
Grundik Kasyansky (electronics), Sebastian Lexer (piano+)
Great Hall, Goldsmiths College, New Cross, London, UK

02.12.2011
Jane Dickson (piano + electronics), Sebastian Lexer (piano+)
University of East Anglia, Norwich

25.10.2011 Muddy Ditch #2
Sebastian Lexer (piano+) & Steve Noble (drums)
Ute Kanngiesser (cello) & Sebastian Lexer (piano+)
Cafe Oto, Dalston Junction, London
Audio Example: 2011-10-25_LexerNoble.wav
Audio Example: 2011-10-25_KanngiesserLexer_25-10-11.mp3

29.08.2011 Workshop series:
Norman Adams (cello), Jamie Coleman (trumpet), Grundik Kasyansky (electronics) & Sebastian Lexer (piano+)
Cafe Oto, Dalston Junction, London

20.08.2011 Solos series:
Sebastian Lexer (piano+)
Madame Lillie's, 10 Casanove Road, Stoke Newington N16, London, UK

02.07.2011 Unwhitstable Festival:
Aleks Kolkowski (stroh violin, gramophone), Sebastian Lexer (organ + electronics)
St Peter's Church, Whitstable, Kent, UK
Audio Example: 2011-07-02_Kolkowski_Lexer_Whitstable.wav

27.06.2011 Workshop Series:
Paul Abbott (percussion, electronics), Jamie Coleman (trumpet), Ute Kanngiesser (cello), Grundik Kasyansky (electronics), Ross Lambert (guitar), Sebastian Lexer (piano+), Eddie Prévost (percussion), Guillaume Viltard (bass) & Seymour Wright (saxophone)
Cafe Oto, Dalston Junction, London

18.06.2011 SITES + SUBJECTS Performance Art Festival Art Academy,
workshop & concert - Sebastian Lexer (piano+)
Plovdiv, Bulgaria

01.05.2011 Ulrichsberger Kaleidophon 2011:
solo by Sebastian Lexer (piano+)
Jazzatelier Ulrichsberg, Ulrichsberg, Austria
Audio Example: 2011-05-01_Festival-Ullrichsberg-Austria.wav
Broadcast on Austrian Radio OE1 27.05.2011 (http://oe1.orf.at/programm/275537)
Broadcast on German Radio SWR2 15.05.2011 (http://www.swr.de/swr2/programm/sendungen/jazz/-/id=659242/nid=659242/did=8144952/9a9395/index.html)

24.05.2011 There Is Still A Body
Paul Abbott (electronics) & Sebastian Lexer (piano+)
la cellule 133, 1060, Brussels

09.03.2011 A B A Concert/Forum/Concert
Sebastian Lexer (piano+)
Goldsmiths College, New Cross, London SE14

06.03.2011 As Alike As Trees 2011 Festival
Sebastian Lexer (piano+) & Christoph Schiller (Spinet)
Hume Studio, the Rag Factory, 16 Heneage St, London E1
Audio Example: 2011-03-06_SchillerLexer_AAAT2011.mp3

06.01.2011
Eddie Prévost (percussion), Ute Kanngiesser (cello), Paul Abbot (electronics), Seymour Wright (saxophone), Sebastian Lexer (piano+) & Raed Yassin (double bass)
Cafe Oto, Dalston Junction, London

10.12.2010 Total Meeting Festival
solo/solo/duo by Sebastian Lexer (piano+) & Marcus Schmickler
Le Petit faucheux, Tours, France

03.12.2010
Seymour Wright (saxophone) & Sebastian Lexer (piano+)
Cafe Oto, Dalston Junction, London

29.11.2010 Workshop series:
Ute Kanngiesser (cello) & Sebastian Lexer (piano+)
Cafe Oto, Dalston Junction, London

26.11.2010
Seymour Wright (saxophone) & Sebastian Lexer (piano+)
Potsdam, Germany

25.11.2010
Seymour Wright (saxophone) & Sebastian Lexer (piano+)
Thomas Kumlehn (flute), Seymour Wright (saxophone) & Sebastian Lexer (piano+)
Stubniz, Rostock, Germany

24.11.2010
solo+solo+duo of Seymour Wright (saxophone) & Sebastian Lexer (piano+)
Exploratorium, Berlin, Germany

18.11.2010
solo by Sebastian Lexer (piano+)
ICA, London, UK

13.11.2010 Rendez-Vous festival
Eddie Prévost & Sebastian Lexer - duo
Setubal, Portugal

28.06.2010 Workshop series:
Paul Abbott (ee), Ross Lambert (guitar) & Sebastian Lexer (piano+)
Cafe Oto, Dalston Junction, London

27.06.2010
Sebastian Lexer (piano+)
The Vortex, 11 Gillett Square, London
Audio Example: 2010-06-27_Solo@Vortex.wav

02 - 06.06.2010 Aspekte 2010
Sebastian Lexer (piano+), Nicolas Rihs (bassoon) & Michael Vorfeld (percussion)
06.06. Imprimerie Basel, Basel, CH
04.06. Atelier Pia Maria, Biel, CH
03.06. Kesselhaus, Weil am Rhein, Germany
02.06. Werkstatt für improvisierte Musik WIM, Zürich, CH

27.05.2010
Seymour Wright (saxophone) & Sebastian Lexer (piano+)
Spanski borci, Ljubljana, Slovenia

26.05.2010
Seymour Wright (saxophone) & Sebastian Lexer (piano+)
Studio 14 Radio Slovenija, Ljubljana, Slovenia
live broadcast on National Radio Slovenia.

22.05.2010
Jennifer Allum (violin), Grundik Kasyansky (electr.), Sebastian Lexer (piano+), Seijiro Murayama (perc.), Eddie Prévost (perc.), Seymour Wright (sax), Daichi Yoshikawa (electr.)
St Marks Church, Myddelton Square, London EC1

03.05.2010 Freedom of the City Festival 2010
Pascal Battus (electr.), Jamie Coleman (trumpet) & Sebastian Lexer (piano+)
Conway Hall, Red Lion Square, Holborn, London
Audio Example: 2010-05-03_BattusColemanLexer_FOTC2010.wav

26.04.2010 Workshop series:
Matt Milton (violin) & Sebastian Lexer (piano)
Cafe Oto, Dalston Junction, London

19.04.2010 INTERLACE
Jennifer Allum (violin), Jamie Coleman (trumpet), Ute Kanngiesser (cello) & Sebastian Lexer (piano+) Great Hall, Goldsmiths, New Cross, London

27.03.2010
solo performance Sebastian Lexer (piano+)
as part of the NYCEMF from the 25-27 March 2010.
Elebash Hall, CUNY Centre, Manhatten, NYC

20.03.2010
Sebastian Lexer (piano+) & Keith Rowe (guitar + electronics) solo/solo/duo
Diapason Gallery, Brooklyn, New York
Audio Example: 2010-04-20_LexerRoweDuo@DiapasonNYC.wav

22.02.2010
duo of Paul Abbott (electr.) & Sebastian Lexer (piano+),
quartet with Paul Abbott, Sebastian Lexer, Toshimaru Nakamura (electr.) & Havard Volden (guitar)
Cafe Oto, Dalston Junction, London

09.02.2010 INTERLACE
Sebastian Lexer (piano+) & Cristoph Schiller (spinet)
Great Hall, Goldsmiths, New Cross, London

25.01.2010 Workshop Series:
David O'Connor (flute), Laura Hyland (guitar, voice), Sebastian Lexer (piano+), Matt Milton (violin), Matt Olczak (electric guitar) & Tim Yates (guitar)
Cafe Oto, Dalston Junction, London

24.01.2010
Sebastian Lexer (piano+)
Cafe Oto, Dalston Junction, London

22.01.2010
Electronic Music For Piano by John Cage
(John Tilbury (piano) & Sebastian Lexer (electronics))
Cafe Oto, Dalston Junction, London

12.01.2010
Sebastian Lexer (piano+) & Cristoph Schiller (Spinet)
Klingentalstrasse 72, Basel, CH

07.12.2009 INTERLACE
Sebastian Lexer (piano+), Eddie Prévost (percussion) & Seymour Wright (saxophone)
Great Hall, Goldsmiths, New Cross, London

21.11.2009 INTERLACE
Paul Abbott (electronics), Ute Kanngiesser (cello) & Sebastian Lexer (piano+)
Great Hall, Goldsmiths, New Cross, London

17.11.2009
9! (Paul Abbott, Jamie Coleman, Ute Kanngiesser, Grundik Kasyansky, Ross Lambert, Sebastian Lexer, Eddie Prévost, Guillaume Viltard & Seymour Wright)
ICA, London

30.10.2009 LISTEN #01
Sebastian Lexer (piano+) & Seymour Wright (saxophone)
Eglise St Merri, 76 rue de la Verrerie, 75004 Paris
Video Example excerpt: 2009-10-30_LexerWright_filter@Paris.mov
Video Example excerpt: 2009-10-30_LexerWright_pianoGranulation@Paris.mov
Video Example excerpt: 2009-10-30_LexerWright_granulationInteraction@Paris.mov
Video Example excerpt: 2009-10-30_LexerWright_sculpture@Paris.mov

07.10.2009 Nonclassical:
Jamie Coleman (trumpet), Matt Hammond (guitar) & Sebastian Lexer (piano)
Macbeth in Hoxton, London

02.10.2009 Dialogue Festival:
Sebastian Lexer (piano+) & Seymour Wright (saxophone)
Inspace, University of Edinburgh

09.08.2009
Marjolaine Charbin (piano), Frans Van Isacker (saxophone) & Olivier Toulemonde (sound objects)
La Cellule 133, Brussels

29.06.2009 workshop series:
duo improvisation with Walter Cardew (guitar)

Cafe Oto, Dalston Junction, London

11.06.2009 the unnamed music festival
duo improvisation with Aleks Kolkowski (Stroh Violin, Grammophones)
Cafe Oto, Dalston Junction, London

01.06.2009 INTERLACE
duo improvisation with Seymour Wright (saxophone)
Goldsmiths, New Cross, London

21.05.2009
solo improvisation - piano+
Aberdeen University, Aberdeen

13.05.2009
solo improvisation - piano+
Vestry Hall (Thames Valley University), Ealing, London
Video Example excerpt: 2009-05-13_solo_VestryHall_TVU.mov

04.05.2009 Freedom of the City Festival 2009:
duo improvisation with Seymour Wright (saxophone)
Conway Hall, Red Lion Square, London

14.04.2009
quartet improvisation with Jamie Coleman (trumpet), Grundik Kasyansky (electronics) & Seymour Wright (saxophone)
Cafe Oto, Dalston Junction, London

23.03.2009 PhD upgrade concert
solo improvisation (using the piano+) and improvised trio with Frédéric Blondy (piano) and John Edwards (double bass)
Goldsmiths, New Cross, London

10.03.2009
solo improvisation (using the piano+)
City University, London

23.02.2009
improvised duo with Grundik Kasyansky (electronics)
Cafe Oto, Dalston Junction, London

26.01.2009
7 of 9! (with Nat Catchpole (saxophone), Jamie Coleman (trumpet), Ross Lambert (Guitar), John Lely (unspec.), Sebastian Lexer (piano+), Eddie Prévost (percussion) & Seymour Wright (saxophone)
Cafe Oto, Dalston Junction, London

21.11.2008
duo improvisation with Seymour Wright (saxophone)
Atelier Tampon-Ramier, Paris

06.11.2008
duo improvisation with Seymour Wright (saxophone),
performance to mark the launch of the CD blasen available from anothertimbre.com
Cafe Oto, Dalston Junction, London

18.09.2008
duo improvisation with Dave Ryan (clarinet)
Cafe Oto, Dalston Junction, London

28.07.2008
quartet improvisation with Jamie Coleman (trp), Jerry Wigens (clarinet) and Seynour Wright (saxophone)
Cafe Oto, Dalston Junction, London

31.05.2008 INTERLACE
Mike Bullock (banjo, electronics), Jamie Coleman (trumpet), Angharad Davies (violin), John Lely (unspec.), Sebastian Lexer (piano+) & Seymour Wright (saxophone)
Great Hall, Goldsmiths College, London

24.05.2008 INTERLACE
Sebastian Lexer (piano+), Guillaume Vittard (double bass) & Jerry Wigens (clarinet)
Deptford Townhall, London

15.05.2008
improvised solo
Theatre, Brighton University, Brighton

22.04.2008
Publican Enemy: Mick Grierson (eletr., visuals), John Lely (at proxy), Sebastian Lexer (piano+), Roger Redgate (violin), Matthew Wright (turntable) and Sam Bailey (keys)
School of Music Canterbury, Broadstairs, UK

23.02.2008 INTERLACE
Martine Altenburger, Frédéric Blondy, Jamie Coleman, Bertrand Gauguet, Ross Lambert, John Lely, Sebastian Lexer & Seymour Wright
Great Hall, Goldsmiths College, London

16.02.2008
9! - Nathaniel Catchpole (tenor saxophone), Jamie Coleman (trumpet), Jerry Wiggens (clarinet), Eddie Prévost (percussion), Samantha Rebello (flute), Sebastian Lexer (piano+), Ross Lambert (guitar / pocket trumpet), Tara Stuckey (clarinet), Seymour Wright (alto saxophone), Michael Rodgers (guitar) and Jari Kankua (alto saxophone), Maya Dunietz (prepared piano)
Saint Mark's Church, Myddleton Square, London

26.01.2008 INTERLACE
Norman Adams (cello), Sebastian Lexer (piano+) & Eddie Prévost (percussion)
Great Hall, Goldsmiths College, London

16.12.2007
trio improvisation with Massimo Carrozzo (clarinet) and Laurent Hoevenaers (cello)
Atelier Tampon-Ramier, Paris

14.07.2007 INTERLACE
Publican Enemy: Dario Bernal Villegas (drums), Mick Grierson (electr. + visuals), John Lely (at proxy), Sebastian Lexer (electronics), Roger Redgate (violin), Matthew Wright (turntable)
Great Hall, Goldsmiths College, London

13.07.2007
trio improvisation with Ross Lambert (guitar) and Seymour Wright (sax)
Vortex, London

14.06.2007 'man and machine'
Benedict Drew (laptop), Phil Durrant (laptop), John Lely (laptop), Sebastian Lexer (laptop) & Mattin (laptop)
Shunt Vaults, London Bridge

07.05.2007 Freedom of the City Festival 2007
Improvisation with 9!
Red Rose, London

12.04.2007 suddenlyLISTEN
Improvisations with Norman Adams (cello+electronics), Sebastian Lexer (piano+) & Lukas Pearse (double bass+electronics)
St Mary Gallery, Halifax, Canada

08.04.2007
Improvisations with Norman Adams (cello+electronics), Sebastian Lexer (electronics), & Scott Tompson (trombone)
NOW Lounge,Toronto, Canada

06.04.2007
Improvisations with Norman Adams (cello), Sebastian Lexer (piano+), Nilan Perera (guit) & Scott Tompson (trombone)
Arraymusic, Toronto, Canada

07.03.2007
Improvisation with Nico Christian (bass), Sebastian Lexer (piano+) &Tara Stuckey (clarinet)
Battersea Arts Centre, London

09.02.2007
Improvisation with Matthew Milton (violin), Ross Lambert (guitar) & Sebastian Lexer (piano+)
The Space, London

12.02.2007 Clear Spot on ResonanceFM
Improvisation with Sebastian Lexer (electronics), Roger Redgate (violin), Matthew Wright (turntable) & Seymour Wright (saxophone)
Live Broadcast, ResonanceFM, London

03+04.02.2007 INTERLACE
9!:
Goldsmiths College, University of London

19.12.2006 Live Algorithms for Music:
Improvisation with Dario Bernal Villegas (drums) and Thanos Chrysakis (vibes + electronics).
Goldsmiths College, University of London

09.11.2006
Improvisation with Tom Chant (sax), Ross Lambert (guitar), Sebastian Lexer (piano+) & Matthew Milton (violin)
Shunt Vaults, London Bridge
released as track on *that mysterious forest below London Bridge* Matchless Recordings, MRCD 40, 2007

26-29.10.2006
Thomas Kumlehn (flute), Sebastian Lexer (piano+/organ+*) & Jerry Wigens (clarinet)
1. concert: Ev. Kirche, Marquardt, Germany*
2. concert: Altes Rathaus, Potsdam, Germany
3. concert: STRALAU 68, Berlin, Germany

14.10.2006 INTERLACE
Improvisation with Jamie Coleman (trumpet), Ross Lambert (guitar), Sebastian Lexer (piano+) & Seymour Wright (sax)
Goldsmiths College, University of London

03.06.2006
Improvisations with Pascal Battus (electr.), Frédéric Blondy (piano), Massimo Carrozzo (clarinet), Bertrand Gauguet (sax), Laurent Hoevenaers (cello), Sebastian Lexer (piano +) and Frédéric Nogray (glas bowls)
Atelier Tampon-Ramier, Paris

10-12.04.2006 evoMUSART 2006
Improvising Duo: Ollie Bown (laptop) and Sebastian Lexer (laptop)
ArtPool, Budapest, Hungary

02.02.2006
Solo performance
SARC, Belfast

28+29.01.2006 INTERLACE
Bertram Denzler, (sax) Frédéric Blondy (piano), Jean-Luc Guionnet (sax), Jean-Sebastién Mariage (guitar), Edward Perraud, (drums) Ross Lambert, (guitar) John Lely (electr. + objects), Sebastian Lexer (piano+), Seymour Wright (sax)
Goldsmiths College, University of London

19.12.2005 Live Algorithms for Music:
Improvising Duo: Thanos Chrysakis (vibes, electronics) and Sebastian Lexer (piano+)
Goldsmiths College, University of London

10.12.2005 INTERLACE
Improvising Duo: Sebastian Lexer (piano+) and Michael Young (piano + electronics)
Goldsmiths College, University of London

28.10.2005 Opening of the Centre for Contemporary Music Cultures:
Performance of Pool by John Zorn
Roger Redgate (violin/prompter), John Lely (unspecified), Sebastian Lexer (piano+), Matt Wright (turntables), Sammy Nikdel (guitar), Emmanuel Spinelli (guitar), Jean-Michel Unglas (guitar), Dario Bernal Villegas (percussion)
Goldsmiths College, University of London

13.10.2005
Improvising Trio with Tetuzi Akiyama (guitar) and Nathaniel Catchpole (sax)
Ongaku_enjoy_sound
Red Rose Club, London

10.10.2005
Solo Performance
improvising Duo with Marko Ciciliani (no input mixer)
University of East Anglia, Norwich

15.09.2005 Live Algorithms for Music:
Improvising Duo with John Lely (electronics),
Goldsmiths College, University of London

29.06.2005
Solo performance: Study III - shifting focus by Sebastian Lexer (piano+)
Goldsmiths College, University of London

18.06.2005 Sonic Arts Network Expo 966
Live Algorithm Group, Improvising Trio with Michael Young, Sebastian Lexer, Tim Blackwell, Swarm algorithm.
Hull University, Scarborough

30.04.2005 INTERLACE
Jamie Coleman, Sebastian Lexer & Eddie Prévost
Goldsmiths College, University of London

23.04.2005 "Double - Trouble",
performance musicale en trois actes "FrancAngleterre", Bertram Denzler, (sax) Frédéric Blondy (piano), Jean-Luc Guionnet (sax), Jean-Sebastién Mariage (guitar), Edward Perraud, (drums) Ross Lambert, (guitar) John Lely (electr. + objects), Sebastian Lexer (piano+), Seymour Wright (sax)
Atelier Tampon-Ramier, Paris

19.02.2005 Sonic Interaction
Trio: Lawrence Casserley (computers), Michael Young (piano+electronics) and Sebastian Lexer (piano+)
Goldsmiths College, University of London

08.01.2005 LMC festival
9!: Nathaniel Catchpole (tenor saxophone), Jamie Coleman (trumpet), Ross Lambert (guitar, preparations), John Lely (keyboard), Sebastian Lexer (piano+), Michael Rogers (guitar), Shakeeb Abu Hamdan (Guitar), Eddie Prévost (percussion), and Seymour Wright (alto saxophone).
LSO St-Lukes, Old Street, London

14.12.2004 Live Algorithms for Music:
Improvising Trio with Jonathan Impett (meta-trumpet), Sebastian Lexer (piano+) and John Tilbury (piano)
Goldsmiths College, University of London

26.06.2004 INTERLACE
John Edwards (double bass) John Tilbury (piano) & Sebastian Lexer (piano+)
Goldsmiths College, University of London

26 & 30.04.2004
Performance by Sebastian Lexer and pianist John Tilbury (voice, piano) of Samuel Beckett's Cascando. Recorded as part of BBC Music Live, at the Ulster Hall on Monday 26th April. Broadcast on BBC Radio 3 on the 30.04.2005 Ulster Hall, Belfast, North Ireland

27.03.2004 INTERLACE
Jeff Cloke (electronics), Sebastian Lexer (piano, laptop), Tony Moore (cello) & Guillermo Torres (trp)
Goldsmiths College, University of London

01.02.2004
9! (Nathaniel Catchpole (tenor saxophone), Jamie Coleman (trumpet), Ross Lambert (guitar, preparations), John Lely (piano), Sebastian Lexer (piano), Takehiro Nishide (guitar), Eddie Prévost (percussion), and Seymour Wright (alto saxophone))
Chats Palace, Hackney London

Appendix II – Performers

Collaborations with performers in the years 2004 - 2011 have included Eddie Prévost and John Tilbury, who as friends and mentors have stimulated aspects of the performance practice. Seymour Wright, Ross Lambert, Jamie Coleman, Paul Abbott, Ute Kanngiesser and Grundik Kasyansky, who have been musical peers for many years in and around Prévost's Improvisation Workshop, and Frédéric Blondy and Bertrand Gauguet who contributed to establish links to international concert opportunities. Other musical encounters with established performers included John Edwards, Jonathan Impett, Steve Noble, Christoph Schiller, Tetuzi Akiyama, Seijiro Murayama, Toshimaru Nakamura, Takehiro Nishide, Lawrence Casserley, Mattin, Michael Vorfeld, Marcus Schmickler and Keith Row.

Comprehensive list of performers collaborated with in the period between 2004 - 2011:

Paul Abbott (perc, electronics)
Shakeeb Abu Hamdan (Guitar)
Norman Adams (cello + electronics)
Tetuzi Akiyama (guitar)
Jennifer Allum (violin)
Martine Altenburger (cello)
Sam Bailey (keyboard)
Pascal Battus (electronics)
Dario Bernal Villegas (drums)
Tim Blackwell (laptop)
Frédéric Blondy (piano)
Ollie Bown (laptop)
Mike Bullock (banjo, electronics)
Walter Cardew (guitar)
Massimo Carrozzo (clarinet)
Lawrence Casserley (laptop)
Nathaniel Catchpole (tenor saxophone)
Marjolaine Charbin (piano)
Nico Christian (bass)
Thanos Chrysakis (vibes + electronics)
Marko Ciciliani (no input mixer)
Jeff Cloke (electronics)
Jamie Coleman (trumpet)
Angharad Davies (violin)
Hutch Demouilpied (trumpet)
Bertram Denzler (saxophone)
Jane Dickson (piano + electronics)
Benedict Drew (laptop)
Maya Dunietz (prepared piano)
Phil Durrant (laptop)
John Edwards (double bass)
Bertrand Gauguet (saxophone)
Mick Grierson (electronics, visuals)
Jean-Luc Guionnet (saxophone)
Matt Hammond (guitar)

Laurent Hoevenaers (cello)
Laura Hyland (guitar, voice)
Jonathan Impett (meta-trumpet)
Frans Van Isacker (saxophone)
Jari Kankua (alto saxophone)
Ute Kanngiesser (cello)
Grundik Kasyansky (electronics)
Aleks Kolkowski (Stroh violin, gramophones)
Thomas Kumlehn (flute)
Ross Lambert (guitar, pocket trumpet)
John Lely (laptop)
Jean-Sebastien Mariage (guitar)
Mattin (laptop)
Matt Milton (violin)
Tony Moore (cello)
Seijiro Murayama (percussion)
Toshimaru Nakamura (electronics)
Takehiro Nishide (guitar)
Steve Noble (drums)
Frédéric Nogray (crystal singing bowls)
David O'Connor (flute)
Matt Olczak (electric guitar)
Lukas Pearse (double bass, electronics)
Nilan Perera (guitar)
Edward Perraud (drums)
Eddie Prévost (drums, percussion)
Samantha Rebello (flute)
Roger Redgate (violin)
Nicolas Rihs (bassoon)
Michael Rodgers (guitar)
Keith Rowe (guitar + electronics)
Dave Ryan (clarinet)
Christoph Schiller (spinet)
Marcus Schmickler (electronics)
Tom Soloveitzik (tenor saxophone)
Tara Stuckey (clarinet)
John Tilbury (piano)
Scott Tompson (tronbone)
Guillermo Torres (trumpet)
Olivier Toulemonde (sound objects)
Guillaume Viltard (bass)
Havard Volden (guitar, electronics)
Michael Vorfeld (percussion)
Jerry Wiggens (clarinet, guitar)
Seymour Wright (saxophone)
Matthew Wright (turntable)
Raed Yassin (double bass)
Tim Yates (guitar)
Daichi Yoshikawa (electronics)
Michael Young (piano + electronics)

Appendix III – Publications

Publications of CDs and Papers from 2003 - 2011

CDs

John Tilbury and Sebastian Lexer. *Lost Daylight*. Another Timbre, at10, 2010

Sebastian Lexer. *Dazwischen.* Matchless Recordings, MRCD74, 2009

Sebastian Lexer and Seymour Wright. *Blasen.* Another Timbre, at13, 2008

Tom Chant, Ross Lambert, Sebastian Lexer & Matt Milton; Jamie Coleman, Mark Wastell & Seymour Wright; AMM (Eddie Prévost, John Tilbury). *That Mysterious Forest Below London Bridge*. Matchless Recordings, MRCD70, 2007

John Tilbury, Christina Jones, Eddie Prévost, Sebastian Lexer. *John Tilbury Plays Samuel Beckett.* matchless recordings, MRCD62, 2005

9! (Nathaniel Catchpole, Jamie Coleman, Alex James, Ross Lambert, John Lely, Sebastian Lexer, Marianthi Papalexandri, Eddie Prévost & Seymour Wright). *None(-t)* Matchless Recordings, MRCD54, 2003

Conference Papers and Articles:

Lexer, Sebastian. “Betrachtungen zum Instrument im Bezug zur Freien Improvisation”. in Dieter A. Nanz ed. *Aspekte der Freien Improvisation* (2011): 107-110, Wolke Verlag.

Lexer, Sebastian. “Piano+: An Approach towards a Performance System Used within Free Improvisation” *Leonardo Music Journal*, Vol 20 (2010): 41-46.

Eldridge, A., Bown, O., Lexer, S. “Behavioural Objects for Interactive and Generative Music presented at the Improvisation and Computers” IRCAM workshop 2006, in conjunction with the NIME 06 conference.

Bown, O., Lexer, S.. “Continuous-Time Recurrent Neural Networks for Generative and Interactive Musical Performance” presented at the evoMUSART 2006, Budapest.

Young, M., Lexer, S.. “FFT Analysis as a CreativeTool in Live Performance” presented at the DAFx-03, Queen Mary University, London. (2003).

Appendix IV – *piano+* (version 2011)

Max Patches included on Data-DVD

Figure A1: Complete Screenshot of the Max patches IEXsig~ for the *piano+* version

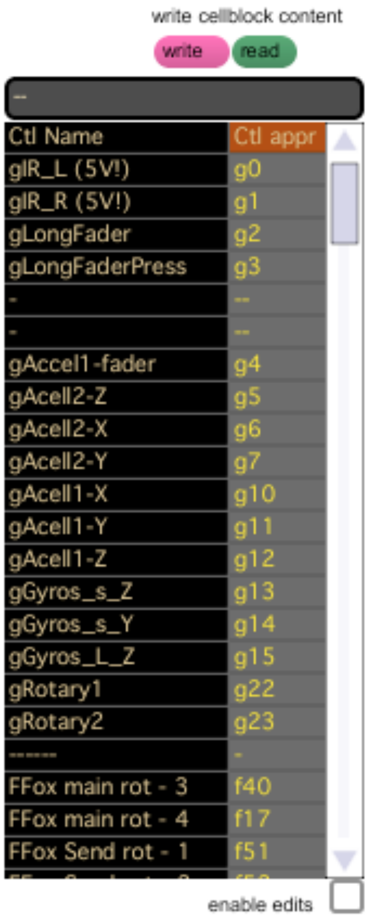

Figure A2: Module (cntlBrowser.iex.maxpat) to define controllers and allowing quick learn function in parameter module

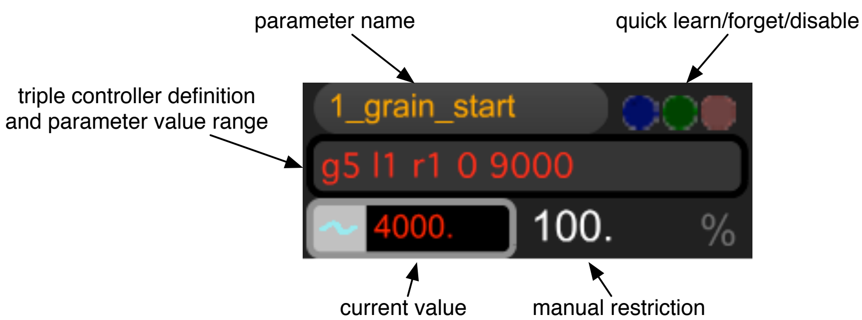

Figure A3: Parameter module (p-r_+multi~.iex.maxpat), allowing the association of up to three controllers and range

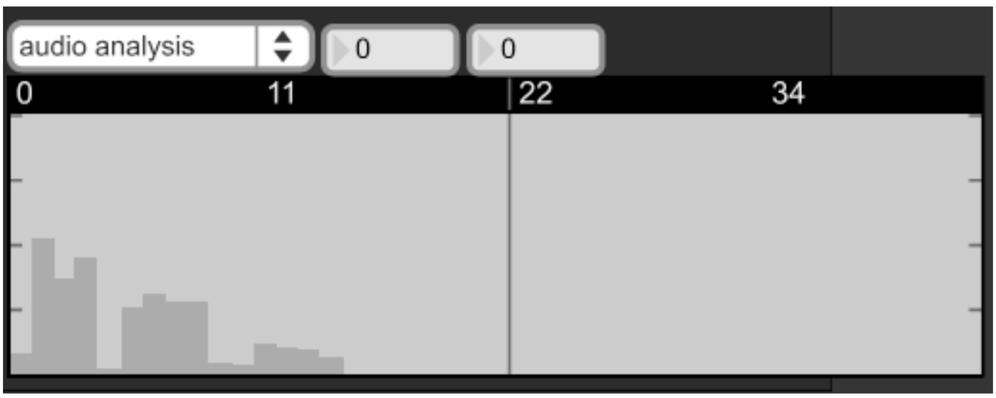

Figure A4: Parameter value database (values stored in audio buffers) (showCtlBufferContent.iex.maxpat)

Figure A5: Granulation module 1 (granulatorModule1.iex.maxpat), maximum recording time 10 seconds. Granulation patches were personally built in Max/MSP taking Granular2.5 by Sakonda as a model and adapted for personal use.

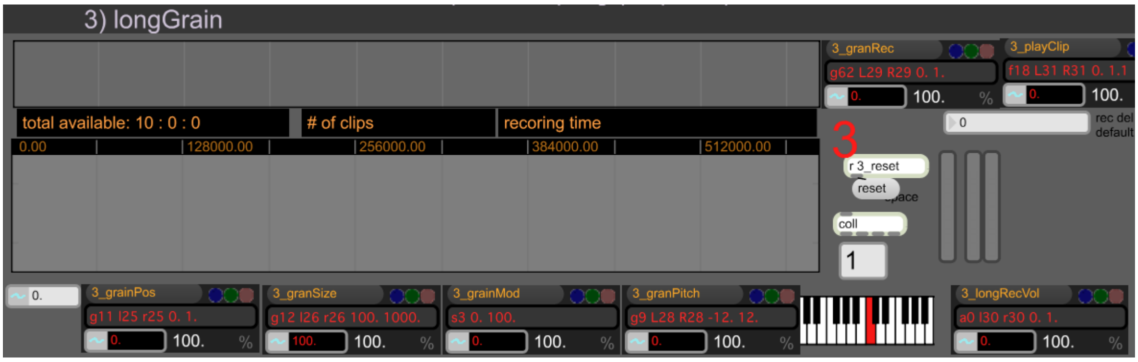

Figure A6: Granulation module 2 (granulatorModule12.iex.maxpat), recording and retrieval of an unlimited number of sections (maximum 10 minutes total recording time)

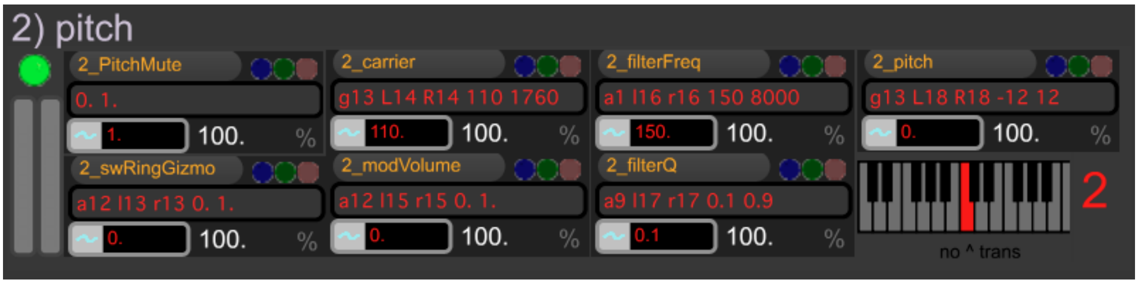

Figure A7: Pitch module (pitchProcesses.iex.maxpat): Ring modulation and real-time transposer (gizmo~ in Max5)

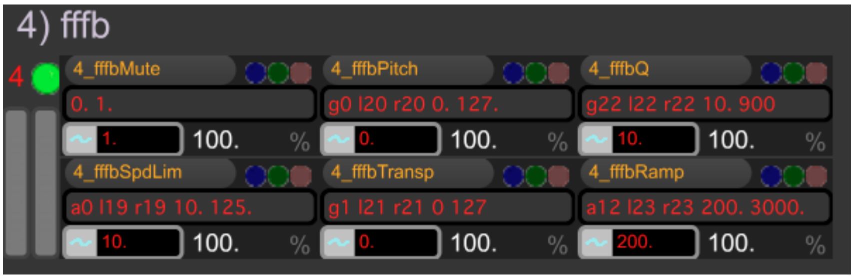

Figure A8: Filter module (filterModule.iex.maxpat, based on the fffb~ in Max5)

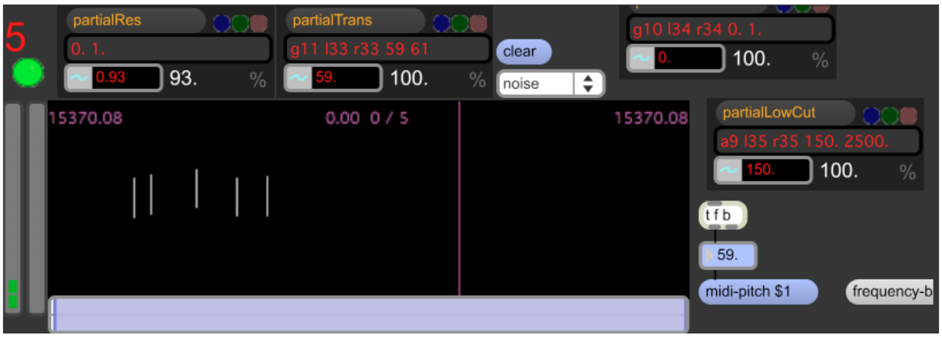

Figure A9: Partial synth module (partialResonator.iex.maxpat, using resonators~ by CNMAT http://cnmat.berkeley.edu/patch/4019)

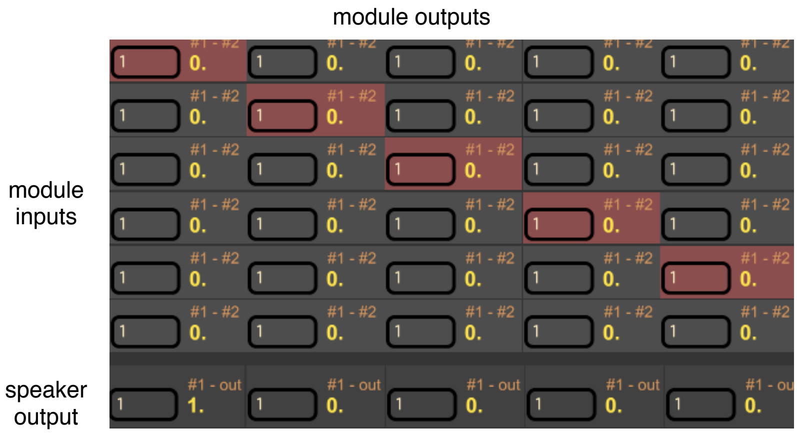

Figure A10: Output matrix mixer (returnMixMatrix.iex.maxpat)

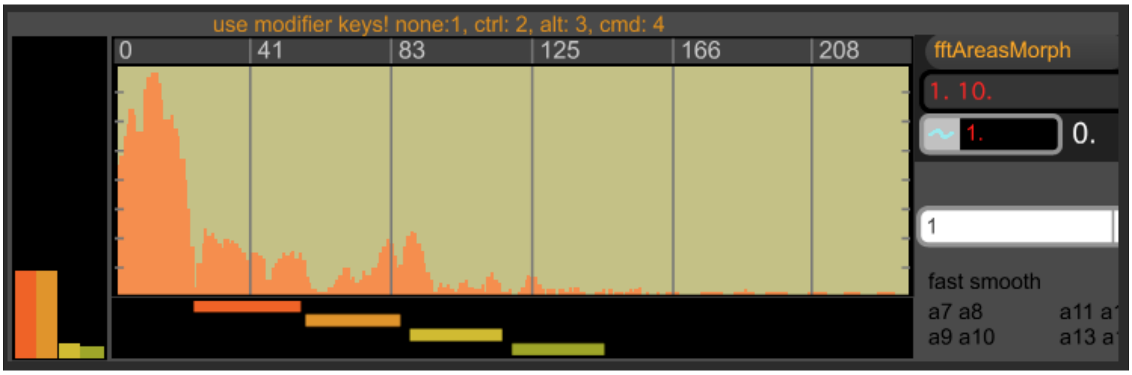

Figure A11: Audio Analysis module (AudioAnalysis.iex.maxpat, using fiddle~, bonk~ and yin~ by IRCAM)

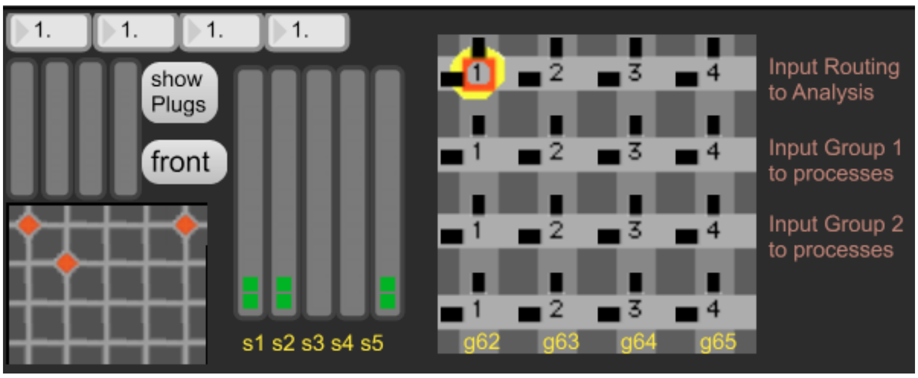

Figure A12: Input matrix for effect and analysis routing (inMatrix.iex.maxpat)

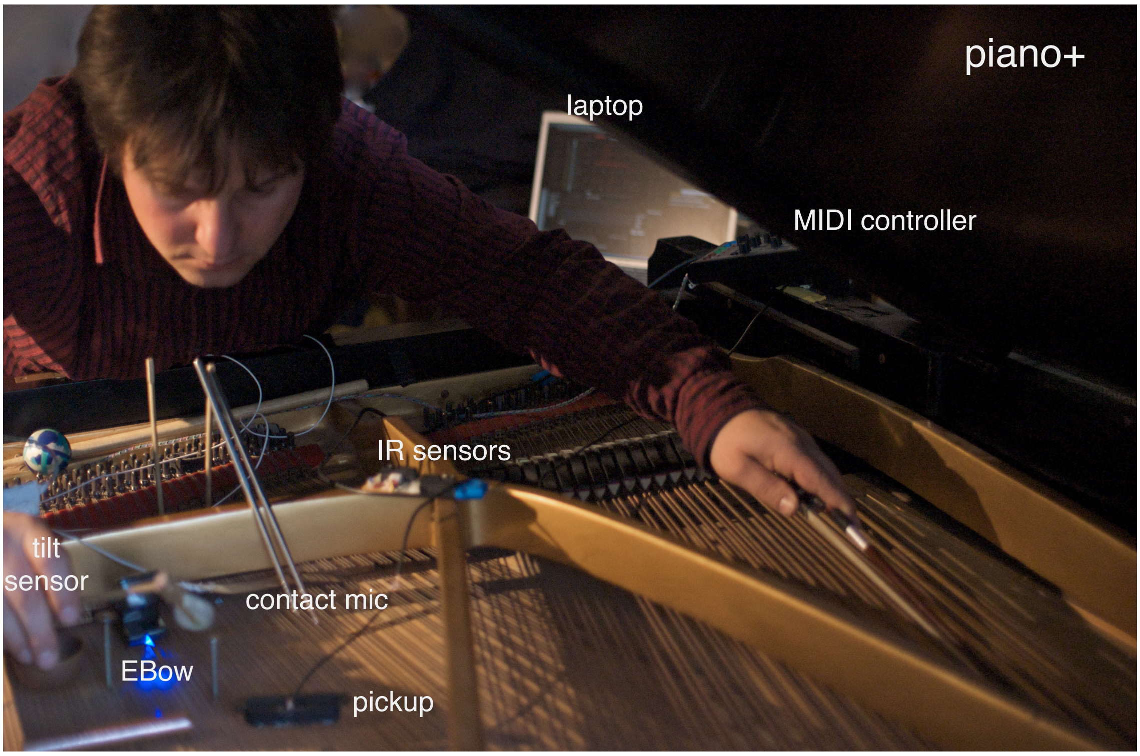

Figure A13: *piano+* preparations, tools, sensors, contact microphone and pickup (photo © Elke Schwarz 2010)

Figure A14: *piano+* preparations, tools and sensors
The sensors are connected to the gluion board sending the sensor data as OSC via the ethernet connection to Max. (photo © Sebastian Lexer 2010)

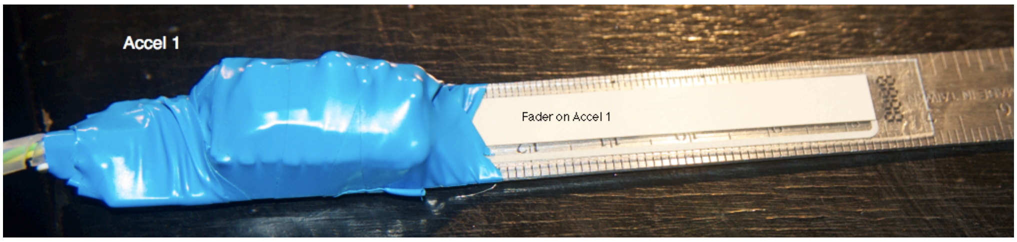

Figure A15: tilt sensor Accel 1 mounted on a metal ruler with an additional touch sensor strip. Acceleration sensors ADXL335 , Touch sensor strip.

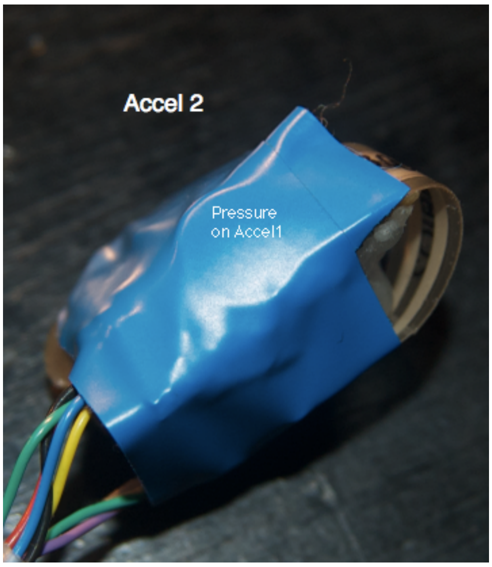

Figure A16: tilt sensor Accel 2 with an additional pressure sensor

Current hardware list of setup:

Apple MacBook Pro 2.66 GHz i7 processor
RME Fireface 400
UAD-2 expresscard (http://www.uaudio.com/support/uad/solo-laptop-support)
2 x iPod Touch 1st gen running FantaStick app by Pink (www.pinktwins.com/fantastick/)
1 x iPod Touch 4th gen running touchOSC app (hexler.net/touchosc/)
AKG C414 microphone
Lavalier microphone by Sanken.
Contact Mics (Piezo films http://windworld.com/products-page/electronic-hardware/piezo-films/)
Pickup (Lollar Oversized Magnetic Pickup http://windworld.com/products-page/electronic-hardware/lollar-oversized-magnetic-pickups/)
4 channel Line Mixer
Faderfox micromodule LV2
Gluion Barefoot
2 x Acceleration/tilt sensors ADXL335
2 x Infrared Proximity Sensor Short Range - Sharp GP2D120XJ00F
Various pressure and touch sensor strips

The IEX5 directory on the Data-DVD contains the Max patches used with the piano+ (version 2011). These patches are also available online from http://sebastianlexer.eu/research/piano+. Please read the readme.txt file for hardware requirements and setup instructions.

Appendix V – *piano+* (version 2005)

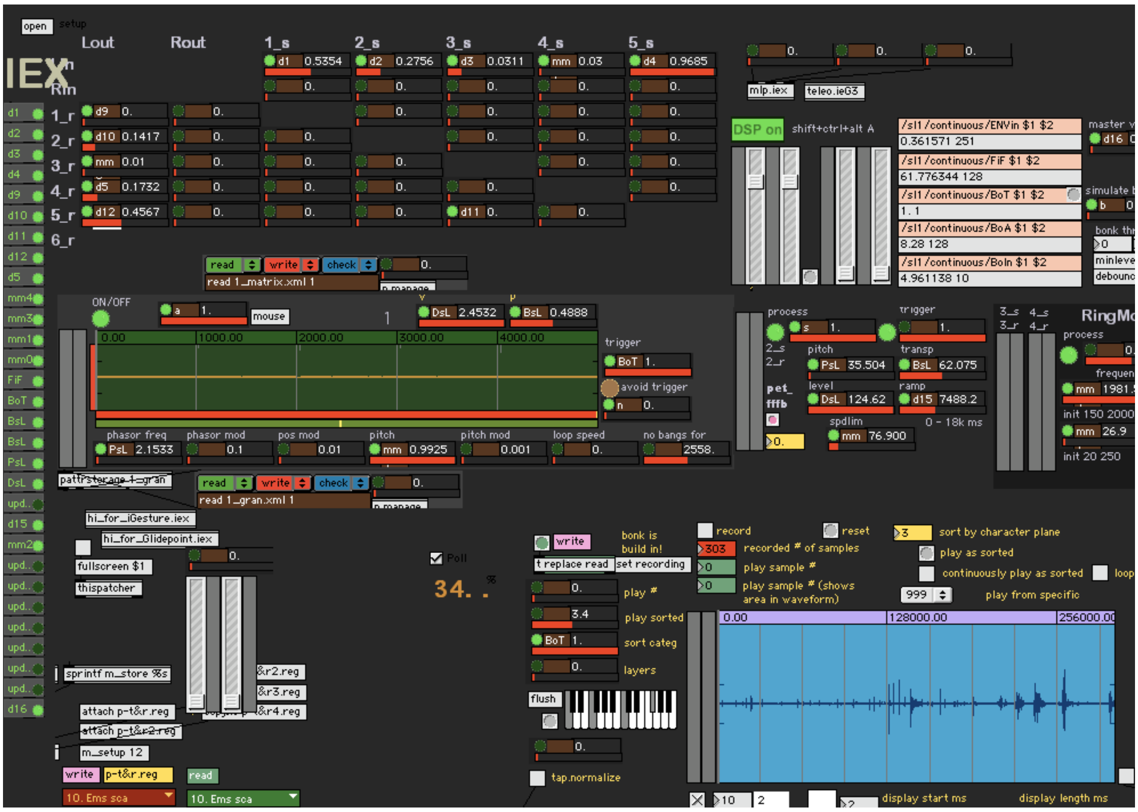

Figure B1: *piano+* patches version 2005

Figure B2: Granulation module version 2005

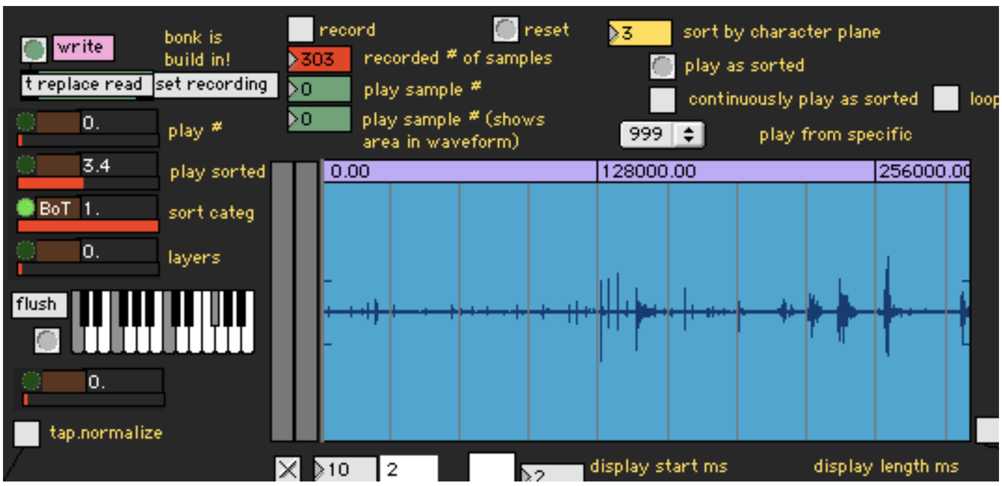

Figure B3: Live Sampling module version 2005

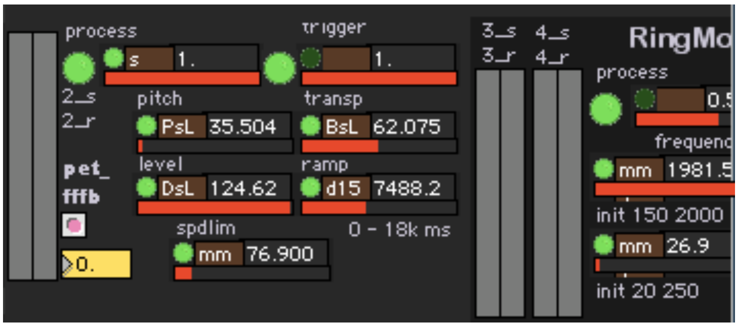

Figure B4: fffb~ Filter and RingModulator module version 2005

Figure B5: output matrix mixer module version 2005

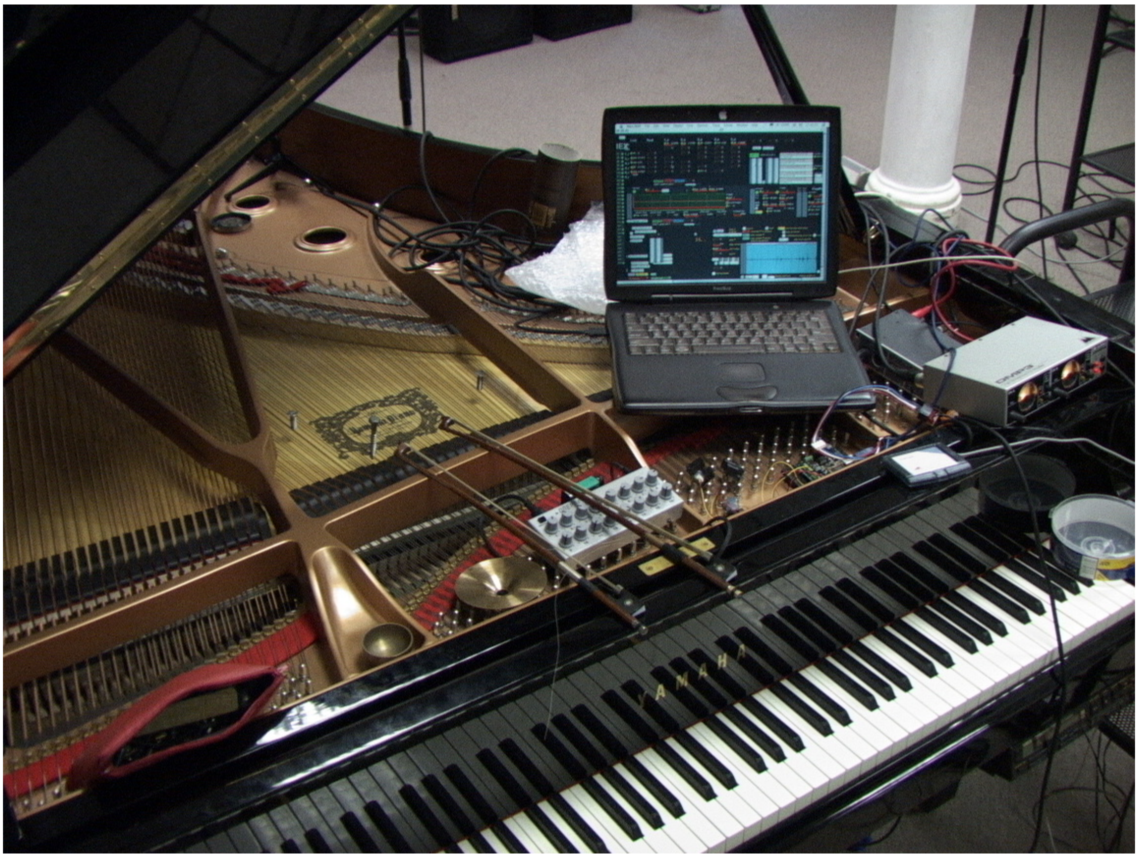

Figure B6: Setup *piano+* (version 2005) in the EMS studio, Goldsmiths College, 01.06.2005

Figure B7: Setup *piano+* (version 2005) in the EMS studio, Goldsmiths College, 01.06.2005, also showing the second laptop used for video tracking and colour-mediated analysis.

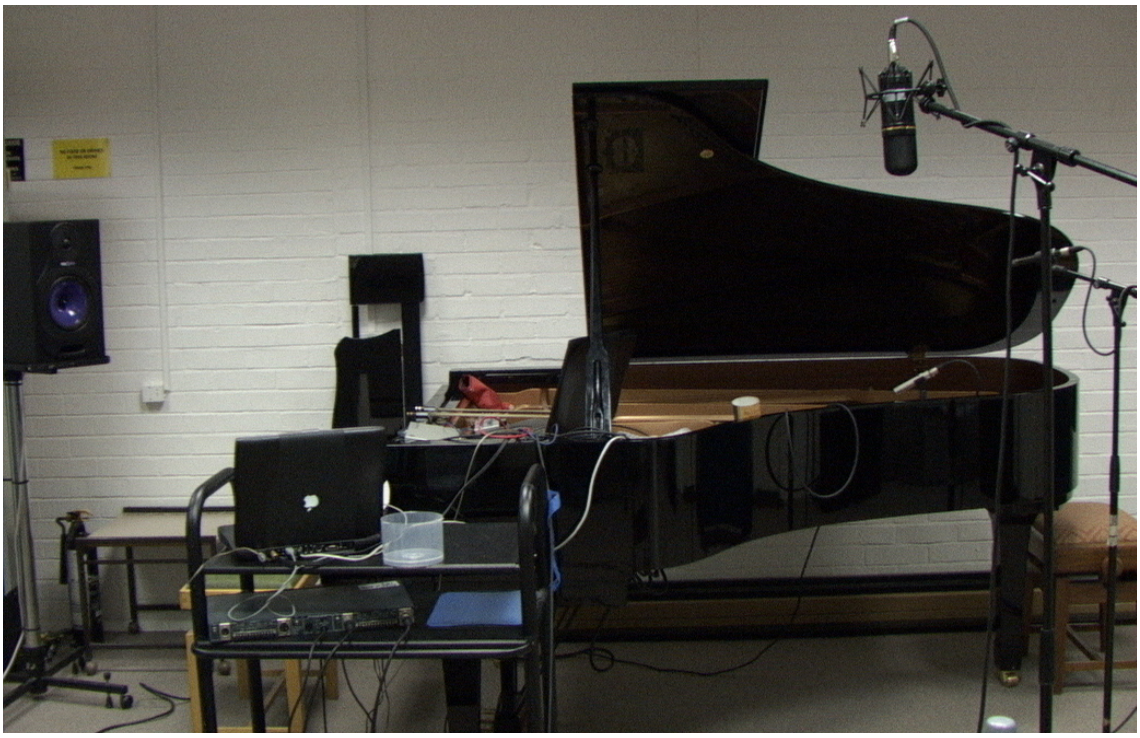

Figure B8: Setup *piano+* (version 2005) in the EMS studio, Goldsmiths College, 01.06.2005, also showing the second laptop used for video tracking and colour-mediated analysis.

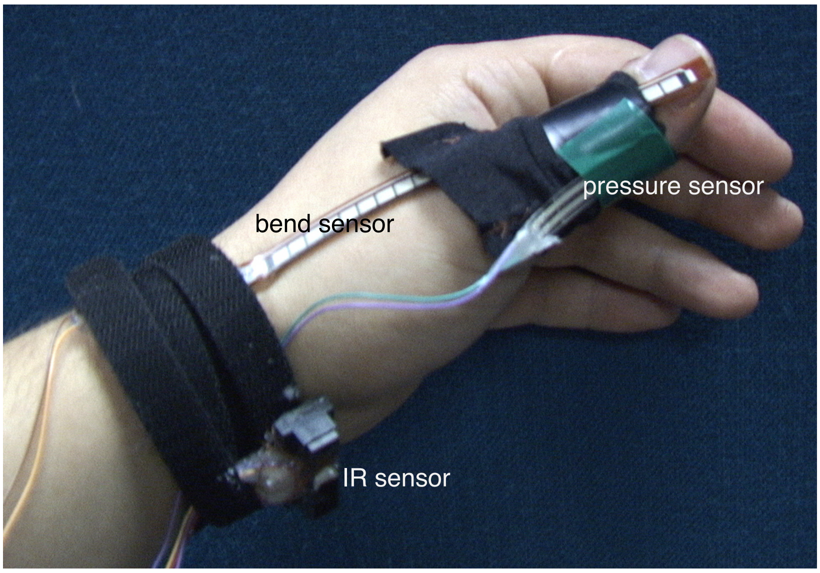

Figure B9: experimental ‘glove’ with distance, bend and pressure sensors

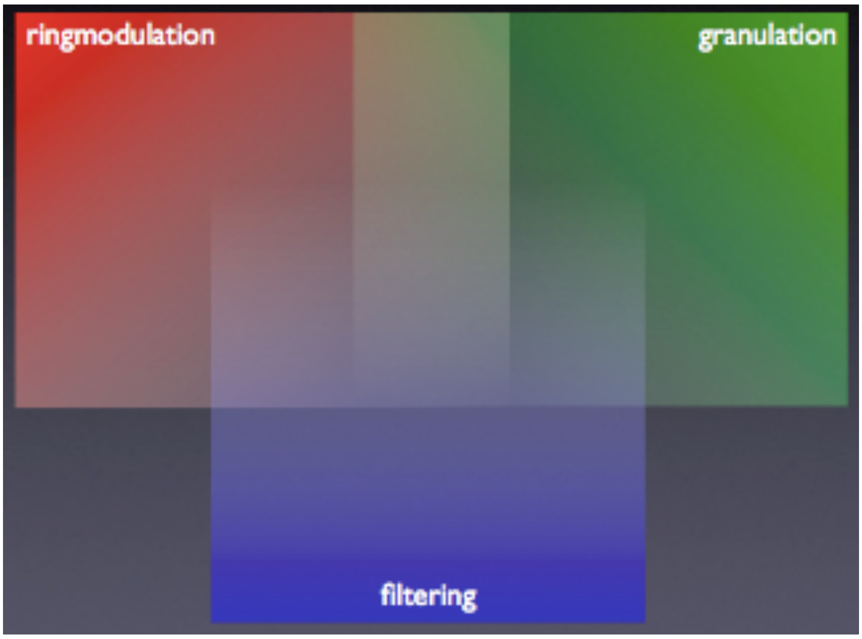

Figure B10: colour value based parameter mapping to be used in conjunction with an XY controller, e.g. trackpad, video colour tracking or colour-mediated audio anaysis (see Figure A19)

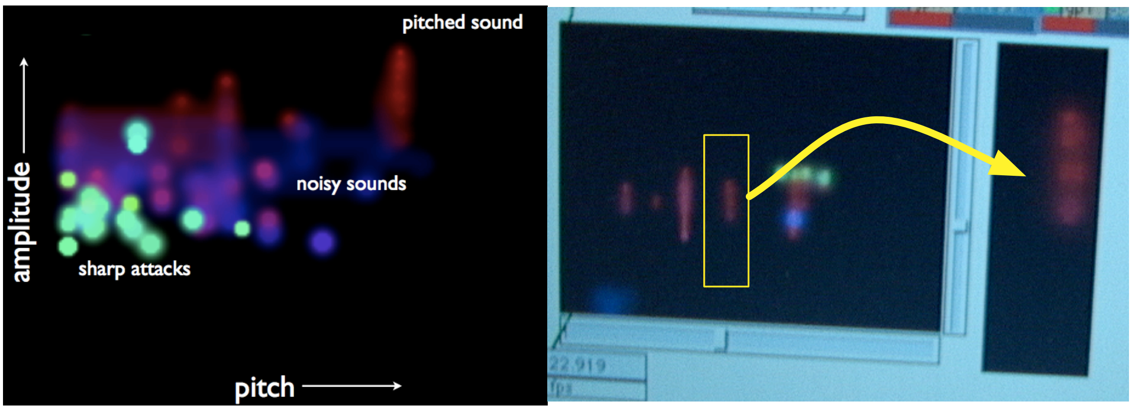

Figure B11: example of visualisation of audio analysis: colour-mediated audio analysis. On the right a segment of the overall spectrum analysed is used to generate an indirect control stream.

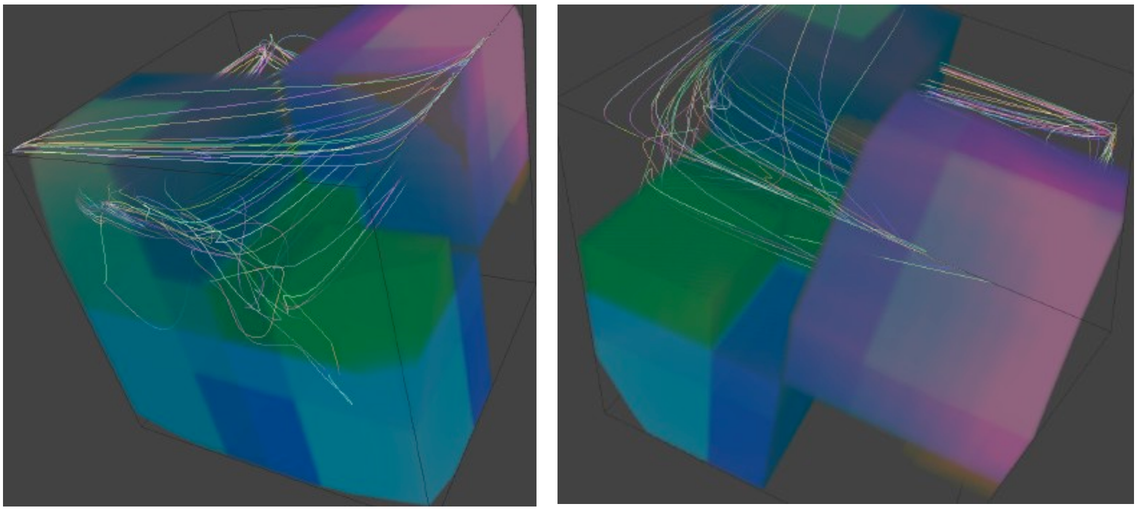

Figure B12: Example of the colour-mediated parameter space, usable to make colour based parameter control available for a three dimensional input vector. This has been successfully applied in combination with Ollie Bown's CTRNN (Bown and Lexer 2006) but also in combination with indirect controls derived from audio analysis and sensors (see Chapter 4.2.2 and 4.6)

Appendix VI – Audio Examples (CDs + DVDs)

Item 1:

Sebastian Lexer (piano+) and Seymour Wright (saxophone), Blasen

Audio CD, released on Another Timbre, at13, 2008.

track 1: *blase_37:18*

track 2: *blase_25:34*

Item 2:

Sebastian Lexer (piano+), *Dazwischen*

Audio CD, released on Matchless Recordings, MRCD74, 2009.

track 1: *time* 09:40

track 2: *defining edges* 07:17

track 3: *rapprochement* 07.22

track 4: *tone* 05:29

track 5: *abscissa and ordinate* 14:02

track 6: *opposition* 11:59

Item 3: "Extended Technique Methods"

Audio CD with audio examples of the extended technique methods:

All examples are recorded using the middle C (except M13(copper string) and M26(copper string)

methods M0 - M28 displayed in Chapter 4.1.2, pages 96-100:

in **Chapter 4.1.2.1**

track 1: M0: conventional sound production on the grand piano

track 2: M1: muting sound by placing finger on strings close to the bridge (3 examples)

track 3: M2: producing harmonics by placing finger lightly on the nodes of the string (5 examples)

in **Chapter 4.1.2.2**

track 4: M3: placement of preparation between strings as introduced by John Cage (3 examples)

track 5: M4: loosely placing objects on the strings causes additional vibrations (3 examples) track 6: M5: placing and holding an object on the string on the string

track 7: M6: placing and sliding object on the string after or while key is played

track 8: M7: plucking a string behind the damper (first example)

M7b: plucking in front of the damper (second example)

in **Chapter 4.1.2.3**

track 9: M8: hitting or flicking a string behind the damper (first example)

M8b: hitting or flicking in front of the damper (second example)

track 10: M9: plucking a string with inserted preparation

track 11: M10: plucking a preparation

track 12: M11: plucking a string with an object

track 13: M12: plucking a string with an object loosely placed on it

track 14: M13: sliding/stroking on string

track 15: M13(copper string) sliding/stroking on a copper wound string (like in Henry Cowell's Banchee (1925)

track 16: M14: sliding object on string

track 17: M15: sliding along preparation (2 examples)

track 18: M16: hitting string and sliding (2 examples)

track 19: M17: hitting a preparation

track 20: M18: flicking a preparation

track 21: M19: hitting/flicking a string with preparation (2 examples)

track 22: M20: hitting/flicking with an object loosely placed (2 examples)

track 23: M21: hitting string with beater

track 24: M22: hitting preparation with beater

track 25: M23: sliding beater on string

track 26: M24: placing beater on string and plucking or hitting the string (3 examples)

in Chapter 4.1.2.4

track 27: M25: sliding stick on strings

track 28: M26: bowing strings (3 examples)

track 29: M26 (copper strings) : bowing a copper wound string (2 examples)

track 30: M27: sliding objects on strings (middle C and neighbouring strings)

track 31: M28: removing a preparation to deliberately make a sound (2 examples)

in Chapter 4.1.2.5

track 32: Realisation of Figure 4.1

Item 4:

Data-DVD with audio and video files in wav, mov and mp3 formats

in order of appearance: (audio/video example file names, included on Data-DVD)

mentioned in **Introduction:**

Solo performances:

audio files of complete performances:

2009-03-23_MPhilPhDupgradeConcert.mp3

2010-06-27_Solo@Vortex.wav

2011-05-01_Festival-Ullrichsberg-Austria.wav

excerpts of video:

2009-05-13_solo_VestryHall_TVU.mov

Ensemble Performances:

audio files of complete performances:

2010-03-20_LexerRoweDuo@DiapasonNYC.wav

2010-05-03_BattusColemanLexer_FOTC2010.wav

2011-03-06_SchillerLexer_AAAT2011.mp3

2011-07-02_Kolkowski_Lexer_Whitstable.wav

2011-10-25_LexerNoble.wav

excerpts of video:

2009-10-30_LexerWright_filter@Paris.mov

2009-10-30_LexerWright_granulationInteraction@Paris.mov

2009-10-30_LexerWright_pianoGranulation@Paris.mov

2009-10-30_LexerWright_sculpture@Paris.mov

mentioned in **Chapter 2**:

page 52:	Recording of experimental session in the EMS, Goldsmiths College, London, on the 31.10.2008
Data-DVD	2008-10-31_ButcherLexer.wav

mentioned in **Chapter 3**:

page 76:	Recording of the solo set of the MPhil/PhD upgrade concert in the Great Hall, Goldsmiths College, London, on the 23.03.2009
Data-DVD	2009-03-23_MPhilPhDupgradeConcert.mp3

mentioned in **Chapter 4**:

page 92:	performance from the 20.08.2011 Solos series: Sebastian Lexer (piano+)
Data-DVD	not available
page 92:	performance from the 20.08.2011 Solos series: Sebastian Lexer (piano+)
CD Blasen	*Blase_25:34* (track 2)
page 92:	Butcher and Lexer (minutes: 2:30 - 10:30)
Data-DVD	2008-10-31_ButcherLexer.wav
page 96-100:	**(track listing see Item 3)**
Audio CD	**Audio CD "Extended Technique Methods"**
page 110:	
	2005-06-01_dataGloveTest_ex1.wav
	2005-06-01_dataGloveTest_ex2.wav
Data-DVD	2005-06-01_dataGloveTest_ex3.wav
page 112:	Example sample playback in different transpositions
Data-DVD	2007-04-20_liveSamplingVariation.aif
page 112:	Example sample playback in different transpositions
Data-DVD	2007-04-20_liveSamplingVariation.aif
page 113:	Example sample playback loudness mapped to centroid
Data-DVD	2007-04-20_liveSamplingVariation2.aif
page 114:	Examples Live Sampling
	2007-10-07_DBV+SL@TCM_ex1.wav
	2007-10-07_DBV+SL@TCM_ex2.wav
Data-DVD	2007-10-07_DBV+SL@TCM_ex3.wav

page 117:	Examples counterpoint through granulation
	Rapprochement (minutes 2:35 - 5:33)
	Opposition (minutes 0:00 - 3:05)
CD Dazwischen	*Opposition* (minutes 5:20 - 6:11)

page 124:	Electronic version of *Piano Piece 2002* by Michael Parsons
Data-DVD	Parsons_PianoPiece2002.mp3

page 125:	*Study III* performed at Goldsmiths 29.06.2005
Data-DVD	Study_III_(shifting_focus).mp3

page 127	*Electronic Music for Piano* by John Cage, performed by John Tilbury (piano) and Sebastian Lexer (electronics)
Data-DVD	Cage_ElectronicMusicForPiano.mp3

mentioned in **Chapter 5**:

page 154:	
CD Dazwischen	*Tone* (minutes 0:00 - 0:50)

mentioned in **Chapter 6**:

page 169:	Audio excerpt visualised in Chapter 6 Figure 6.1
Data-DVD	2007-01-23_electroStudy_ex

page 170:	Audio excerpt visualised in Chapter 6 Figure 6.2
Data-DVD	2007-03-26_piano+cataRT_ex

page 170:	Audio excerpt visualised in Chapter 6 Figure 6.2
Data-DVD	2007-03-26_piano+cataRT_ex

page 174:	Example for granulation
CD Dazwischen	*Time* (minutes 5:00 - 6:59).

page 174:	Example of acoustic sounds superseded by the electronic continuation
CD Dazwischen	*Rapprochement* (minutes 2:15 - 6:30).

page 176:	
	Time (minutes 7:00 - 9:07)
CD Dazwischen / Data-DVD	*Defining edges* and 2007-01-23_electroStudy.wav
page 177:	Example of sonic sculpture
CD Dazwischen	*Rapprochement* (minutes 2:38 - 5:18).
page 179:	duo recordings with Seymour Wright
CD Blasen	
page 180:	Example of Seymour Wright's interplay with extended instrument space.
	Blase_25:34 in particular the closing minutes of the track.
	also Video Example excerpt:
CD Blasen / Data-DVD	2009-10-30_LexerWright_sculpture.mov
page 181/182:	duo with the drummer Steve Noble, Cafe Oto, 25.10.2011:
Data-DVD	2011-10-25_LexerNoble.wav
page 182:	duo with Ute Kanngiesser, Cafe Oto, 25.10.2011:
Data-DVD	2011-10-25_KanngiesserLexer.mp3
page 182:	duo with Aleks Kolkowski, Whitstable 02.07.2011:
Data-DVD	2011-07-02_Kolkowski_Lexer_Whitstable.wav
page 182:	duo with Christoph Schiller, Rag Factory, London, 06.03.2011:
Data-DVD	2011-03-06_SchillerLexer_AAAT2011.mp3

The IEX5 directory contains the Max patches used with the piano+ (version 2011). These patches are also available online from http://sebastianlexer.eu/research/piano+. Please read the readme.txt file for hardware requirements and setup instructions.