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Approaches to notation in music for piano and live electronics: the performer's perspective

Abstract

This chapter examines elements of notation in mixed music for piano and live electronics. The author introduces examples from the repertoire and discusses different notational approaches. These are grouped into three main categories.

1. Graphic notations and visual representations, or ‘descriptive’ scores (Boorman 2001) are commonly used in repertoire with fixed media to simplify synchronisation, and can also be found in more recent repertoire with interactive live electronics.
2. Tablature-style notations, or prescriptive scores (*ibid*) that include notation-as-documentation offer a different and potentially complementary approach.
3. Hybrid combinations of approaches and notations including semi-improvised pieces and notation for new instruments show new perspectives in the field.

The author addresses performance practice challenges and draw conclusions from the performance perspective.

1. Introduction: Raising Questions

Musicians are often faced with notational challenges when interpreting twentieth-century and contemporary repertoire (Fox 2014, 7). These issues become more apparent as composers depart from traditional milieus and performing situations in instrumentation and intent. In the context of mixed repertoire with electronics, the lack of unified notation has been identified as a major issue. Gregorio Garcia Karman writes: ‘Like other forms of writing, a score for electroacoustic music is not a neutral means of representation but the expression of a system of relations; you have to understand the language to be able to read the text. But the notation of electroacoustic music is not based on a widely accepted system of signs; there are a number of dialects’ (Karman 2013, 154). Thus, the performer is effectively required to learn a new dialect almost every time he or she learns a new piece.

In notated music for instruments with live electronics, the problems of notation and communication multiply further. Complex set-ups often result in the lack of rehearsal time, at times necessitating that performers internalise their parts without even hearing the electronic processing (Tutschku 2011, 395). The role of the sound projectionist or computer performer can become more demanding, in many cases calling for duo or chamber-like interactive relationships (Pestova 2009, 119)¹. At times, the score contains more information than reasonable for page turns, requiring reduction, as we will see below. In addition to instructions for spatialisation and

¹ For examples of duo-type notation systems for piano and an electronics performer, see Austin (1992), Essl (1985) and Montague (1983-93). Each work calls for actions such as live processing, spatialisation or real-time recording and playback to be carried out by the second musician.

synchronisation that can be found in fixed media pieces, musicians might be required to execute complex trigger points, for example with a MIDI pedal. At the same time, notation of the electronics often remains sparse or even non-existent (Nicolls 2010, 38), partly due to the complexity or unpredictability of live electronic behaviours as well as the lack of accepted conventions. These issues raise further questions as soon as we introduce elements of improvisation and indeterminacy into performance.

This chapter explores several approaches to notation in mixed music for piano and other keyboard instruments through a survey of a selection of repertoire in this genre. Discussion is grouped into three broad categories: abstractions and graphic representations of electronic sound, tablature-style notational systems, and hybrid approaches that include combinations of these categories, improvisation as well as new or modified instruments.

1.1 On Terminology

Currently, there is no unified terminology in the field of mixed electronic music. For the purposes of this discussion, pieces for ‘piano and tape’, ‘piano and playback’, ‘piano and CD’, ‘piano and soundtrack’, ‘piano and electroacoustic sound’ etc. will be termed simply as ‘piano and fixed media’. Similarly, the term ‘live electronics’ will refer to both real-time processing of instrumental sound and real-time triggering of previously recorded and processed sound (as opposed to playing with a fixed recording). This will include pieces for ‘piano and computer’, ‘piano and interactive electronics’ and ‘piano and interactive electroacoustics’. While this approach does not retain the composers’ original descriptions, it is hoped to add clarity to the discussion.

2. Background: the Score in Electronic Music

Composers have struggled with notation of electronic music since the early studio experiments. Pierre Schaeffer’s dilemmas are well documented in his research on *musique concrète*. While working from sketches to record material for ‘Étude aux tourniquets’ in 1949, Schaeffer laments the inadequacy of Western notation and the constrictive nature of imposing bar lines on the freer instrumental gestures (Schaeffer 2012, 17).

Schaeffer goes on to identify ‘two problems of principle: tablature and notation technique’, drawing comparisons to eighteenth-century musical tablature notation and elaborating on the distinction between ‘causal’ and ‘effects’ scores in electronic music (Schaeffer 2012, 76). The ‘causal’, or ‘operational’ score is the tablature required to obtain the effects ‘which, at the present moment, it is impossible to represent accurately with appropriate symbols’ (*ibid*), while the effects score focusses on graphic representation of the sounding result. Much of the notation in repertoire for piano and electronics fits into these two categories. I will discuss ‘effects’ scores, or abstract and coded visual representations of electronic sound, in section 3. ‘Causal’ scores, or tablature notations, will be examined in section 4.

‘Effects’ scores in electronic music can be traced back to the tradition of a so-called diffusion score. While a piece of acousmatic electronic music might be fully realised by the composer in the studio, interpretation can still play a vital role. Even without instrumentalist performers, live diffusion, or articulating the composition spatially in the concert hall through movement on a loudspeaker array, is arguably a performance art. As Jonty Harrison explains, ‘within the acousmatic tradition, descended from *musique concrète*, composition and performance are inextricably linked – diffusion being, in effect, a continuation of the compositional process’ (Harrison 1999, 1). Harrison goes on to state that ‘in performing this music, therefore, it is appropriate that the same type of “physical” gestures that were used to shape material during the process of composition should be used again in performance to reinforce that shape in the audience's perception and to enhance further the articulation of the work's sonic fabric and structure’ (*ibid.*, 3). Again, it is Schaeffer who was the first to discuss tentative experiments with diffusion as interpretation or performance art:

‘...we occupied, fairly recklessly, the magic circle where the usual sight is strings vibrating, bows susurrating, reeds palpitating under the inspired baton of the conductor. The audience had to be content with an infinitely more disappointing sight: turntables and potentiometers, cables and loudspeakers... I had indeed to be there, and, to however small an extent, (apparently), interpret... with no other means of expression than imperceptible hand movements that added to or reduced the general sound level by a few decibels’ (Schaeffer 2012, 61).

Performance and interpretation in this context require a visual reduction of the musical events. While approaches to producing diffusion scores vary, one common tactic is to visually represent the outline of the waveform against a horizontal time grid in order to show the timing and dynamic envelope of the events in the piece². Documentary information such as sound levels or indications of spatialisation³ can also be present, although this is not likely to be a tablature-style score showing execution of events, but rather an abstraction of the sonic result, to be studied closely through repeated listening prior to performance. This approach to notation is often used in mixed music with a live pianist, as discussed in section 3.

Karlheinz Stockhausen took a different approach to Schaeffer not only compositionally by working with purely synthesised sounds but also notationally. In ‘Studie II’ (1954), notation doubles as technical information and documentation, showing meticulously how the work was constructed, and in theory – but not

² *Diffusion Score*, <http://ears.pierrecouprie.fr/spip.php?rubrique168> accessed 11 May 2015.

³ For attempts at formalising spatialisation notation, see <http://blog.zhdk.ch/ssmn/about/>, accessed 20 August 2014.

necessarily in practice⁴ – making it possible to realise the score⁵. Composer Simon Emmerson terms this type of notation the ‘realisation score’ (Emmerson 2006, 4), also comparable to Schaeffer’s ‘causal’ score as described above, but perhaps even more detailed. In the case of ‘Studie II’, the composer thus has complete control over the finished product, arguably leaving little scope for interpretation due to the highly prescriptive and detailed notation (an approach Stockhausen was also to lean towards in instrumental music in his later years, with rigid and crystallised performance practice, leaving little or no scope for interpretation). As we shall see in section 4, this approach to tablature-style notation-as-documentation also surfaces in later mixed works.

It is worth mentioning that specifically designed or transcribed ‘analysis’ (Emmerson 2006, 4) or listening scores can also be produced for the purposes of listening to and following the structural development of a piece of electronic music (Haus 1983). This approach offers an interesting point of departure in complex scores for instruments and electronics. Some works may require a reduction for performance, but can still benefit from a detailed version of the ‘full score’ to aid study while learning the behaviour of the electronic part. We will see an example of this approach in section 3.

3. Abstractions and Codes: Visual Representations of Electronic Sound

This section explores repertoire that uses concepts similar to Schaeffer’s descriptive ‘effects’ scores as a point of departure. As mentioned in the previous section, traditional acousmatic approaches often use a waveform score to aid diffusion. This approach is also used in mixed works. The waveform is placed against the notated instrumental part to help with synchronisation (as shown in the next section, this technique is fundamentally different from a tablature-style notation that has technical information or physical actions as the main focus). We can compare this approach to a visual abstraction of the resulting sound, akin to graphic notation, although it does not necessarily provide information on the sonic texture, being mostly focussed on timing as indicated by volume contours⁶. Jonty Harrison’s piano version of ‘Some of its Parts’ (2014) provides an example of this type of notation in a fixed media context. This piece is a mobile construction for piano, violin, percussion and a fixed soundtrack that can be performed as three solos, three duos or a full trio with the same fixed media part. The waveform of the electronic part is represented visually against a

⁴ Simon Emmerson argues that precise recreation of classic electronic repertoire is not possible as it is unrealistic to replicate exactly the equipment used (Emmerson 2006, 5).

⁵ Similar approaches to producing notation-as-documentation scores can be found in works of other composers such as Luciano Berio (Giomi et al, 2003).

⁶ Pianist Sarah Nicolls writes: ‘These representations are... in practical terms not much use to the performer and simply take up precious space whilst providing no really useful information, so I therefore often cut them out of scores, replacing them with more descriptive words, or a mixture of normal notational devices and graphic shapes’ (Nicolls 2010, 38). This is similar to performers inserting traditional notation in order to simplify the reading of a graphic score, as described by pianist Aloys Kontarsky (Kontarsky and Martin 1972, 73).

time count, with instrumental events aligned proportionally with the salient attacks in the electronic part.

[Insert Figure 1 here]

Figure 1: Jonty Harrison, 'Some of its Parts', page 3 (excerpt)

Harrison foregoes traditional pitch / rhythm relationships due to the somewhat 'unconventional' nature of the material: instead of playing on the keyboard, the pianist acts more as a percussionist, 'colouring' the electronic part and focussing on timbre. The inside of the instrument is divided into five regions by the struts of the piano frame, struck by the pianist with mallets and other implements, and represented with a five-line staff used to notate percussive events and occasional pitches. Spaces between the lines indicate events on the tuning pegs (high, medium or low) and strings. At times, the pedal is depressed to enhance or manipulate resonance and blend with the more reverberant events in the fixed electronic part. For the pianist, the difficulty of this work lies not only in the physical stamina required to stand up and lean into the piano for the duration of the piece, but also in the synchronisation points. At times, strong simultaneous attacks occur after non-pulsed silences. While the performers should aim to internalise the electronic part in rehearsal and learn the timings through repeated listening⁷, accuracy presents a challenge in concert. Adrenalin and varying hall acoustics can influence the perception of time in performance in contrast with the inherent inflexibility of fixed media (Pestova 2008, 10-11). It may be helpful for the performer to incorporate more visual cues that provide information on the timbral qualities of the electronic part in this context.

Heather Frasch takes a somewhat different approach in notating electronics and extended techniques in 'Frozen Transitions' (2014). Scored for flute, piano and live electronics, the piece utilises Frasch's own notations for the non-standard instrumental performance techniques, devised following consultation with the original performers of the piece and at times visually suggesting the texture of the resulting sounds (see Figure 2). In the piano part, different noteheads combined with precisely notated rhythms are displayed spatially to show different registers of the instrument. The noteheads indicate the types of sounds that the pianist generates: sliding on the strings with gloved hands, running drum-kit brushes or chopsticks along the tuning pegs and the keys and plucking strings behind the bridge to create 'untuned' sounds. Frasch outlines the gestural contours of movements that generate the sound world of the piece and builds the flexibility of timing and natural physicality of gestural transitions into the fabric of the work. While the performers do not necessarily synchronise with the electronic part directly – the composer or a computer performer cues different sections, which are subtle and textural, lacking strong rhythmic attacks – it is nonetheless important for the performer to have a visual representation of the computer part in order to blend and interact with it. In this context, it is helpful to consider the computer (and also the computer performer) as a chamber music partner,

⁷ Pianist Philip Mead discusses the learning process in music for piano and fixed media in an interview with the author (Pestova 2011).

and study the full score in order to enhance the performer's understanding, as in traditional ensemble settings (Fox 2014, 8). Frasch uses two systems in the electronic part: real-time amplification of the (mostly extremely quiet) instrumental parts, and playback of samples. The playback staff features numbered trigger cues with a verbal description of what is audible as well as symbolic graphic notation of the sound types and shapes.

[Insert Figure 2 here]

Figure 2: Heather Frasch, 'Frozen Transitions', page 2 (excerpt)

Another type of abstraction or code used to depict resulting sound is the use of Western musical notation (perhaps with some modifications) to show the electronic part. The obvious advantage in this situation is that standard pitch and rhythm notation is a code that is universally understood by trained musicians. However, some limitations of this approach to notation include the lack of existing symbolic depictions for the rich and varied timbral capabilities made available by electronic processing.

One classic example from fixed media repertoire is 'Tombeau de Messiaen' (1994) by Jonathan Harvey. Harvey uses standard pitch and rhythm notation to show the main features of the electronic part in order to aid synchronisation. The composer is careful to state that the pitches written are approximate only, due to the microtonal nature of the material. A more detailed approach is taken by Lou Bunk in 'being and becoming' (2010) for toy piano and live electronics, part of a series of works with the same title featuring different solo instruments. The electronic material consists of sections of previously recorded and manipulated material triggered in real time by the performer, creating flexibility with timing and movement between the different sections of the work. Bunk uses a separate staff to meticulously show the pitch and dynamic envelope of each line in the electronic part. Quartertone notation is used to show the pitch on the staff along with the frequency in Hertz within brackets, resulting in up to ten different staves in addition to the toy piano part.

[Insert Figure 3 here]

Figure 3: Lou Bunk, 'being and becoming', bars 58-60 of full score

This kind of approach can be very useful for an 'analysis' or study score (Emmerson 2006, 4), but makes performance impossible due to the number of page turns required. Following the performer's request, the composer made a reduction performance score that shows the main lines, enough to give a representation of the electronics without cluttering the page. This is comparable to a concerto part with a piano reduction as opposed to playing from the full orchestral score. Bunk includes a separate staff to rhythmically indicate the placement of trigger cues that advance the computer onto the next section (see Figure 4).

[Insert Figure 4 here]

Figure 4: Lou Bunk, 'being and becoming', bars 58-60 of performance score

Combination scores featuring standard notation alongside specially devised symbols also fit into the category of abstractions. Returning to the fixed medium once again, we can find a classic example of this kind of notation in Denis Smalley's 'Piano Nets' (1990). Traditionally notated pitches and rhythmic elements alternate with and morph into abstract shapes and graphics in a temporally aligned space above the piano staff.

[Insert Figure 5 here]

Figure 5: Denis Smalley, 'Piano Nets', page 11 (excerpt)

As an example for piano with live electronics, 'Nostalgic Visions' (2009) by Elaine Lillios shows specifically devised non-standard notation. At times, the pianist is required to improvise on given material, and the composer uses verbal descriptions to provide guidance⁸. In addition to showing when to advance between numbered cues (either with a MIDI trigger pedal or with a second computer performer at the laptop), the electronic part is notated using graphic symbols that reflect the texture and trajectory of the sounds without reference to standard notation. Although it is not possible to imagine or hear the sonic events in one's mind from simply looking at the notation, the graphics still provide an idea of the properties of the sounds and simplify the learning process, allowing the pianist to rely less on repeated listening to the electronic part prior to rehearsal.

[Insert Figure 6 here]

Figure 6: Elaine Lillios, 'Nostalgic Visions', page 2 (excerpt)

4. Tablatures and Notation-as-Documentation

The second category for discussion covers prescriptive instruction-based tablature notations ('causal' scores). These notational systems place emphasis on the actions required to produce the sound and/or technical information needed to realise the score. This style of notation is particularly well suited to 'action music' (such as extended techniques) that is led by physical gesture rather than information on pitch, timbre or rhythm (Kojcs 2011). Composer Juraj Kojcs investigates instructive as opposed to depictive notation based on traditional tablature notations: 'Tablature systems ... preserved the focus on the physicality of the music-making... with information about the placement of the fingers on particular strings or keys, rather than conveying the desired pitch or interval' (Kojcs 2011, 66). Kojcs uses tablature notation in his works for piano and live electronics, 'Three Movements' (2004) and 'All Forgotten' (2006-13). Both pieces offer interesting glimpses of an approach to music as gesture and action.

The two pieces make extensive use of extended techniques. 'Three Movements' separates the inside of the piano into three regions (not dissimilar to Harrison 2014

⁸ Verbal performance instructions or verbal descriptions of electronic sound are often found in scores for piano and live or fixed electronics, at times approaching text score concepts, as explored in Lely and Saunders 2012.

and Frasch 2014), using three lines to represent the high, medium and low strings. Different noteheads and verbal instructions are used to indicate actions such as striking or rubbing the strings or sliding palms along the keys set against minute and second timings. The computer part is colour-coded, denoting differences between elements such as the fixed electronic part, physical string model sounds, piano samples and real-time processing. At times, a waveform of the rhythmic pattern of the fixed electronic part is also given in addition to dynamic shapes and graphic representations of the sonic events.

[Insert Figure 7 here]

Figure 7: Juraj Kojs, 'Three Movements', page 2 (excerpt)

However, as Kojs writes, 'the graphic representation of the computer part is purely referential. The outlined gestures, in particular those of the live-electronics, change from performance to performance.'⁹ While the detailed instructions and explanations of the electronics come close to documentation scores such as Stockhausen's 'Studie II', there is still not enough visual information to recreate the piece without a copy of the composer's Max patch. In this instance, the software effectively becomes a part of the 'notation' required for performance.¹⁰ While we are seeing an action-based notation in the piano part, it is in fact coupled with a primarily abstraction-based notation in the electronic part.

'All Forgotten' is similar in providing detailed instructions and diagrams on the execution of string glissandi to the performer. The pianist rubs resin on their fingers and slides along strings, the pitches marked with conventional musical notation. The computer part consists of verbal descriptions of events taking place and pitch content with rhythmical cues. As before, the computer part does not require specific 'execution' by the pianist or a second performer, reacting to the actions of the pianist instead. Kojs writes: 'Both pieces are based on the piano providing the energy input to motivate a layer of live electronics: for example, through amplitude tracking to excite virtual strings ('Three Movements') and virtual marimbas ('All Forgotten') designed by Stefania Serafin and implemented as external objects in Max.'¹¹

[Insert Figure 8 here]

Figure 8: Juraj Kojs, 'All Forgotten', page 14 (excerpt)

Another example of tablature notation is given in 'Of Dust and Sand' (2010) by Per Bloland for alto saxophone and piano with electromagnets positioned over the strings.

⁹ <http://kojs.net/3MVT.html>, accessed 15 August 2014

¹⁰ Pianist Sebastian Berweck makes a study of the way notation, documentation and software patches need to be provided together and combined in order to make a performance of a live electronic work possible: 'The material with which a performer works [should] consist of the score, one or more patches and instructions' (Berweck 2012, 36).

¹¹ Juraj Kojs, email correspondence with the author, 7 July 2014.

This work follows on from ‘Elsewhere is a Negative Mirror’ (2005) for piano and electromagnets. Both pieces require a Max/MSP patch that controls the magnets’ vibration. The composer writes:

‘Two grand staves are provided for the piano. The lower two staves indicate the pitches generated by the electromagnets, while the upper two staves (labelled Finger Tablature) indicate the actual actions to be undertaken by the performer. The top 7 electromagnets are for the most part ‘on’ throughout the piece, attempting to excite their respective strings. The performer at the piano must lean over the keyboard and press down directly on these 7 strings, thus damping their vibration. When a note is called for in the score, the appropriate finger is lifted off the string, allowing it to vibrate. A note on the tablature staff thus indicates removal of the given finger.’

The tablature contains three lines for the right hand and four for the left, and is complemented by a second staff below indicating the resultant pitches (effectively, a combination of tablature and abstraction scores!). While no other electronic sound is executed or notated, this is a curious and imaginative use of tablature-style notation for a ‘hyper-instrument’, an electromagnetically prepared piano.

[Insert Figure 9 here]

Figure 9: Per Bloland, ‘Of Dust and Sand’, bars 73-75 (piano part)

At times, tablature notation can bear little or no reference to the audible result and require an accompanying set of instructions and a detailed technical rider in order to interpret the work. Larry Austin’s ‘Accidents Two’ for piano and sound projection (1992) is a classic example of an intriguing and mysterious score that would be impossible to realise without detailed study of the instructions. In Austin’s example, both the pianist and the sound projectionist read the same page simultaneously, using the ‘full’ score rather than different ‘parts’, which serves both as a technical and a performance score at the same time. The pianist reads a graphic representation of a waveform, interpreting the outline as relative register positions on the keyboard and attempting to press the keys without activating the strings (the resulting sonic ‘accidents’ provide the pitch material of the work). The sound projectionist interprets numbers to trigger pre-recorded events, arrows to spatialise amplified piano sound, and colour bars to initiate sound processing such as modulation, pitch change, distortion, compression, gating and comb filtering.

[Insert Figure 10 here]

Figure 10: Larry Austin, ‘Accidents Two’, Event 36 1/2

Dominic Thibault’s ‘Igaluk: to Scare the Moon with its own Shadow’ (2012) for keyboard and MIDI controllers with live electronics is another interesting example. The score shows pitches on the keyboard that trigger different sound events with a continuous curve on the bottom staff depicting a volume pedal that controls filtering and distortion (see Figure 10). The score has up to five staves to read simultaneously, and can be challenging to follow due to the fact that ‘heard’ events do not necessarily

correspond to the notated pitches¹². The detailed technical rider forms an integral part of the notation (notation-as-documentation). This approach harks back to the classic ‘sampler’ writing in works such as ‘Related Rocks’ (1997) for two pianists and two percussionists by Magnus Lindberg, with the pianists doubling on Yamaha DX7 keyboards with a bank of samples.

[Insert Figure 11 here]

Figure 11: Dominic Thibault, ‘Igaluk: to Scare the Moon with its own Shadow’, bars 213-15

Cue-based notations in mixed live electronic repertoire provide further examples of tablatures. These are instructional scores that place emphasis on the actions required to trigger a sample or start and stop sound processing rather than describing the nature of the sounds produced. The most common approach in music for piano and live electronics is to use a MIDI trigger foot pedal. ‘Zellen-Linien’ (2007) by Hans Tutschku shows an example of notation that is primarily focussed on the piano, while MIDI pedal trigger points are shown on a separate staff underneath the piano staves with rhythmic cues. Occasionally, the heard samples are shown in musical notation for synchronisation purposes, but most of the electronic behaviours are only referred to in shorthand text in boxes next to the cues (see Figure 11). Sebastian Berweck writes: ‘...in *Zellen-Linien* it is unclear to the pianist what the computer will do... the computer remains a black box and the player has to learn the reactions from the computer by playing the piece often’ (Berweck 2012, 102). While shorthand notation can be a useful aide-mémoire to the composer, the performer can benefit from a more detailed verbal or graphic description in order to simplify the learning process, although this may in turn make page turns problematic. In this situation, composers can consider providing a separate study score with detailed information in addition to the performance score, as in Bunk 2010.

[Insert Figure 12 here]

Figure 12: Hans Tutschku, ‘Zellen-Linien’, page 1 (excerpt)

Working with a MIDI pedal can present challenges and coordination issues for the performer, which can in turn impact composition and notation (Pestova 2008, 20). The nature of the MIDI pedal is different from the regular piano pedals, functioning as an on/off mechanism with no gradations in between (*ibid*, 61-62). Furthermore, due to the lack of vibro-tactile feedback and the nature of some patches there are often no immediate results following the pressing of the pedal (Berweck 2012, 103). This introduces the probability of missing a cue or playing one too many, causing the pianist to unintentionally skip a section of the piece or start a section early. The sheer

¹² This is comparable to performing prepared piano works by John Cage. In these pieces, written pitches do not correspond to the percussive sounds activated by the keyboard. In pieces with electronics, one solution would be to notate the heard samples on a separate staff (although this may be impractical in a work which already uses multiple staves). An example of such notation is given in Nicolls 2010, 20 in a work for piano and keyboard activating samples by Larry Goves titled ‘My name is Peter Stillman. That is not my real name’ (2007).

number and placement of such pedal cues can also provide challenges to reading and execution. ‘Song from the Moment’ (2008) by Bryan Jacobs contains 108 MIDI pedal cues over the 14 minutes of the piece, averaging at 7 per minute. The pianist presses the MIDI pedal simultaneously with many right pedal changes, which can also happen independently. The MIDI pedal is notated graphically with triangular wedge shapes and numbers indicating cue marks. The frequent rhythmical nature of these events may make it more useful for the performer to have this information in rhythmic notation on a separate staff (as in Tutschku 2007), although this space is already taken up with intermittent click track notation (see Figure 13. Note the electronic part attacks, shown graphically, unlike in the Tutschku).

[Insert Figure 13 here]

Figure 13: Bryan Jacobs, ‘Song from the Moment’, bars 84-92

Performance practice difficulties related to multiple MIDI pedal cues are partially resolved in ‘On the Impossibility of Reflection’ (2011) by Scott Wilson. The piece requires a second musician (to date, the composer) to control the electronic part, which runs in *SuperCollider* software. Events and processing are triggered from the laptop, except where tight synchronisation is required. Following the initial rehearsal period with the composer, it was decided that during instances where piano attacks are meant to coincide with attacks in the electronic part, the pianist will trigger the events with a MIDI pedal, resulting in a ‘division of labour’. This is a simple and elegant solution. Wilson notates the pedal cues rhythmically and also shows the rhythmic patterns of the responses in the electronic part (Figure 14).

[Insert Figure 14 here]

Figure 14: Scott Wilson, ‘On the Impossibility of Reflection’, bars 1-4

5. Hybrids, Improvisations, Future Directions

Hybrid notations are interesting to consider when searching for solutions in this context. One classic example of a hybrid notation in piano music is György Kurtág’s intuitive non-rhythmical notation for his series of progressive pedagogical pieces, ‘Játékok’ (1973 - ongoing). While remaining natural in its symbolic depiction of the physical gestures required to produce sounds at the keyboard and including ‘extended’ techniques such as black and white note glissandi and clusters, the notation also attempts to reflect the ‘sounding’ gesture. For example, the use of colour-coding might draw the pupil’s attention to different elements such as dynamics or clusters (big ‘blobs’ of sound marked in red), while glissandi are represented by wavy lines going across the range of the keyboard, getting the child used to spatial and physical orientation at the piano and exploring musical movement (Junttu 2008).

An example of hybrid notation for piano and live electronics can be found in ‘Mantra’ (1970) by Karlheinz Stockhausen. Scored for two pianists who also play percussion and control ring modulation (originally analogue, but now digitised, Pestova et al 2008), the piece mostly uses conventional notation. However, changes between ring

modulator pitches are shown below the piano staff with glissandi, reflecting the direct physical movement of the performers, at times requiring drastic and theatrical gestures when the dials are turned through the whole range. In some instances, the modulating frequency is also indicated in Hertz. The pianists form a ‘super-instrument’ together with the modulation and the percussion, and the notation is a combination of tablature and visual abstraction / graphic representation. This is due to the fact that while the modulating sine tone frequencies are notated, they are never heard directly. Instead, what the performers and the audience hear is a combination of direct piano sound with the ring-modulated piano sound.

A different type of hybrid notation is used in Alistair Zaldua’s ‘contrejours’ (2011-12). The pianist plays harmonics by dampening the strings while striking keys, both the actual and the resulting pitches shown on the two lines of the piano staff. This triggers pre-recorded ‘harmonics’ and resonances in the computer part, shown on the ‘electronics’ staff. Just like in ‘Mantra’, this model is comparable to a hyper-instrument, with the computer literally extending the piano, with the pianist activating the electronic part through the keyboard and the two sound actors blending and morphing into one.

[Insert Figure 15 here]

Figure 15: Alistair Zaldua, ‘contrejours’, page 3 (excerpt)

At times, notation takes a secondary role or is bypassed altogether. This can be the case in semi-improvised and collaborative pieces. Largely improvised works for piano and fixed media in the repertoire include ‘Faisceaux’ (1985) by Annette Vande Gorne and ‘Figures de rhétorique’ (1997) by Robert Normandeau. The pianist performs alongside a fixed soundtrack, but the events in the piano part are notated with a degree of freedom and verbal instructions¹³ to improvise: different types of attacks on repeated notes in the case of Vande Gorne, and pitch collections with a free cadenza-like section in Normandeau. The electronic parts are notated with waveform / attack representation of salient events against a time frame in the style of a diffusion score, similar to Harrison 2014.

Karlheinz Essl and Gerhard Eckel use structured improvisation in combination with striking and original hybrid notations in ‘Con una certa espressione parlante’ (1985) for pianist and tape machine operator. The pianist performs with a range of extended techniques inside the instrument and on the keys (also using props such as mallets and a bottle). At times, the pianist works from traditionally notated pitches and rhythms, shown in the top part of the score (see Figure 16), while also synchronising with material recorded live (Figure 17). The tape machine operator is required to record and play back parts of the pianist’s live performance, as notated in the bottom section. The tape machine operator also ‘scratches’ the tape in real time - a pioneering technique developed especially for the piece by Gerhard Eckel (Fuchs 1986, see

¹³ See also Lillios 2009.

Figure 17). This imaginative notational approach comes with a set of detailed instructions in order to decode the symbols.

[Insert Figure 16 here]

Figure 16: Karlheinz Essl and Gerhard Eckel, Con una certa espressione parlante, page 6 (excerpt)

[Insert Figure 17 here]

Figure 17: Karlheinz Essl and Gerhard Eckel, Con una certa espressione parlante, page 9

Composer and installation artist Patricia Alessandrini takes this approach even further in ‘Schattengewächse’ (2013-14) for toy piano and live electronics. In this piece, the instrument is physically modified in order to limit its possibilities and bypass the need for notation altogether, inviting the performer to explore and interact with the sounds directly. Transducer speakers are placed on the body of the toy piano in order to play sound files as well as excite vibration and create feedback loops through contact microphones inside. The keys are prepared and blocked with a metal ruler, creating various ‘bouncing’ and ‘buzzing’ sounds due to the hammers being in constant proximity to the metal rods inside. The performer is able to modify and shape the resulting resonances and key bounces by shaking the instrument, pressing on the keys, dampening the instrument with their body and eventually removing the blocking ruler to ‘liberate’ the keys. The electronic part is semi-improvised as well, with the second performer controlling the order and rate of change between pre-recorded sound files and levels of amplification for feedback based on the pianist’s response. In this situation, the instrument itself becomes the score through limiting, modifying and shaping its sonic possibilities. This creates an inclusive and interactive performance situation by breaking down potential barriers presented by sign-based notations (Alessandrini and Pestova 2014).

New keyboard instruments can also offer tantalising possibilities in terms of developing new notations. One such instrument is The Rulers, designed and built at McGill University by David Birnbaum and Steven Sinclair as part of the Digital Orchestra Project (see Figure 15).¹⁴ The instrument consists of metal tines that are manipulated by the performer, their position captured by infrared sensors that communicate information to the computer-based synthesis engine (Pestova et al 2009). In addition to striking tines in a piano-like fashion to initiate sounds, the performer is also able to move them in order to shape the sounds following attack. Composer D. Andrew Stuart developed special notation in his piece ‘Sounds Between Our Minds’ (2008) for The Rulers with two other digital musical instruments. Stuart’s notation is a hybrid combining traditional symbols and shapes reflecting tine movement graphically, as well as using tablature-style staves showing which tine should be activated. The Max/MSP patch for the piece also includes a graphic user interface showing which tines are active. The challenge for this project was to develop

¹⁴ http://www.idmil.org/projects/digital_orchestra, accessed 16 August 2014.

new notational methods that compliment the nature of the instrument while drawing on traditional notations to minimise learning time, allowing performers to build on existing motor skills even if the interface does not closely resemble existing instrumental models¹⁵.

[Insert Figure 18a or 18b here if possible]

Figure 18: The author with The Rulers, image by Vanessa Yaremchuk

[Insert Figure 19 here]

Figure 19: D. Andrew Stewart, 'Sounds Between Our Minds', page 4, full score (excerpt). The Rulers notation is shown on the two bottom staves.

6. Conclusions: the Performance Perspective

This brief overview of notation in repertoire for piano and electronics shows the lack of a unified notation protocol and terminology, which continues to be problematic. While there have been some attempts to create or identify unified notations in the past¹⁶, this may prove to be difficult in practice, and it would be naïve to suggest that all composers should focus on one approach due to the varied and personal nature of each piece. However, some conclusions can be made based on the above observations. It is clear that detailed visual representations of the electronic part are useful for the performer in order to facilitate learning and rehearsal, and composers should strive to include this information. It is also useful to note that performer-composer collaboration should not be overlooked when creating new repertoire, as it can inform and enrich notational approaches, as in Bunk 2010, Frasch 2014 and Wilson 2010.

Graphic representations and visual abstractions depicting electronic sound are helpful to the performer for the purposes of coordination, as well as providing an aide-mémoire for the behaviour of their electronic chamber music partner. Following in the tradition of acousmatic diffusion scores, waveform representations can give an idea of the dynamic envelope and salient attacks, and are useful in mixed music with fixed media, although they do not tend to provide specific information on timbre or texture (Harrison 2014). Similarly, using standard notation to show electronic sound is helpful in some instances (Harvey 1994, Bunk 2010), but would not always be practical, depending on the nature of the timbral events in the work in question. Special symbols devised by the composers can show the performer approximate

¹⁵ For more on gestural notation in electronic music, see Tormey 2011.

¹⁶ See Patton 2007 for examples of morphological notation in music for instruments and live electronics that can potentially be adapted to other repertoire. In related work, we attempted to initiate discussion on creating a unified system, or a 'gestural lexicon of mixed music' in Lewis and Pestova 2012. While we felt this to be useful for establishing terminology for gestural types found in mixed electronic music, no unity was found in existing notational approaches.

timbral qualities of sonic events and their placement in time (Lillios 2009), but may not be sufficient to get an idea of the piece without repeated listening to the electronic part. In these cases, a combination of verbal descriptions and graphics can be helpful, as in Frasch 2014.

Tablature notations can be used to show actions required to perform the instrumental and electronic parts (for example, Kojs 2004 and Bloland 2010). These can also take form of notation-as-documentation and technical scores needed to realise the work (Austin 1992). Tablature scores can be particularly challenging to the performer when the notation does not reflect resultant sound (Thibault 2012). For such cases, combinations of tablature and more abstract visual notation can be more successful (Bloland 2010 and Zaldua 2011). The author's conclusion is that notating MIDI pedal cues rhythmically (Tutschku 2007) rather than graphically (Jacobs 2008) is more useful for performance, while dividing cues between the pianist and the computer performer provides a practical solution in order to minimise the number of notated triggers for each performer and simplify coordination (Wilson 2010).

Hybrid notations, semi-improvised scores, modification of existing instruments and working with new instruments all show further directions to consider (for example, Essl and Eckel 1985, Stuart 2008 and Alessandrini 2014). It is hoped that we will see further developments of detailed notations in new repertoire that combine the above methods and draw on successful approaches from the past, such as the use of intuitive gestural notation and colour-coding (Kurtag, 1973, as well as Kojs 2004).

In addition to showing instrumental parts in a transparent and practical way, notation of mixed repertoire should include clear documentation of the electronic parts and the actions required to realise them, such as triggering sound files and processing. At the same time, it should give an indication of the resultant electronic sound through a combination of standard notation, verbal descriptions and graphic symbols. Returning to Pierre Schaeffer once again, we refer to his suggestion of a 'variable' principle of notation, with some elements notated 'with the greatest precision', and others 'with an approximate outline', while difficult-to-analyse sound complexes are to be represented by symbols (Schaeffer 2012, 71). If this amount of information proves to be impractical for a performance score, an alternative solution is to create a special study score for reference with a performance reduction to minimise page turns and facilitate reading (as in Bunk 2010). These approaches enhance visual cues and can greatly aid the performer's learning process and minimise rehearsal time in repertoire with live electronics (which may otherwise demand repeated listening and playing through just to familiarise oneself with the score). Detailed and thorough documentation will also aid the preservation and study of this emerging repertoire for the future.

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