and improvising with Pauline, I was predisposed to think of improvisation as a dialog (often a kinetic one) where improvising occurred against the sounds produced by the other. Working with Pauline taught me very concretely that when improvising solo, duo, or with others, there is always already a dialog but it is between the sounds and not the people – it is between the elements placed on the canvas. In other words, this posits an approach to sound-making that is about listening to what is happening in the space between people, the meaning-making that occurs because people are connecting across music… not speaking to respond, but listening and speaking to further what is made possible by interaction. Awareness of perceptual biases, an acknowledgement of everything – as it is – draws the actions of Manet and Pauline and of technology and music together.

PO: (PO has the last word): We need to be careful of what we build upon. Post-human citizenry is a distinct possibility with old and new political, social, educational, philosophical, and music problems to solve. For me the time is right to investigate the possibility of becoming a post-human citizen. I want to be a transformed musician who listens, creates, collaborates, performs new music, and remains thoughtful and concerned about others no matter who they are or what their origin may be. Technology is taking us on a wild sexy ride into the future. If we are mindful of our purposes, creations, designs, models, and simulations we could open up new and thrilling musical territory as we don't know it.

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Notating Electronics

by Cat Hope

This paper will outline and examine the techniques I have used in my compositions that include electronics. Using graphic notation presented to performers as a moving, animated score, I have notated electronic parts in over fifteen works, mostly within acoustic settings. The works themselves attempt to activate the agency of the electronics performer with a chamber music ensemble. The notations cover a range of roles for electronics within the works that include the illustration of pre-prepared backing tracks, instructions for programmers, live sampling, playback and manipulation, electronic effects for acoustic instruments, spatialisation, feedback control, as well as the representation of electronic instruments such as the Theremin, synthesisers and radio static.

Introduction

The Decibel new music ensemble was formed in 2009 as 'a group of Western Australian musicians, composers, improvisers and sound artists devoted to the realisation of music where acoustic and electronic instruments are represented' [1]. The ensemble is made up of musicians that are also composers and computer programmers facilitating different approaches to writing and reading music. The Decibel ScorePlayer, an iPad application enabling coordinated reading of graphic notations [2], was devised from within the ensemble and has facilitated my composition practice by providing a platform for coordinated performances of graphic notations, such as my own. The application runs a play head over an image coordinating the musicians who read it, removing the need for coordinated clock reading and enabling the smooth, unpulsed coordination of the performers [3]. The score image is converted into a file format (.dsz) that makes it readable in the ScorePlayer [4]. I also create hard copies of all my scores, as landscape, A3 concertina paper copies.

Why Notate?

Live electronic music performance practice is a largely improvised one, and notations for electronic music have remained largely in the realm of representation, that is – after the performance [5]. What about notation for electronic music performance where the same results or processes are to be replicated each time? I was fascinated with the creative capacity of the electronic musician, that I will call an 'electronics performer.'

Notations for electronic components in chamber settings are used to depict a variety of functions such as playback, interactive electronics, electronic instruments or live sampling. Interactive

program components are rarely scored – rather they accompany the notated score as a 'patch' or other software file that renders the electronics in performance. This creates issues for longevity of these works, where operating systems and software programs are constantly being updated, and older versions being discarded. This was of great concern to me – what of all those pieces for instruments and electronics? Who will maintain the electronics parts? A number of compositions require one to 'contact the composer' or pay a fee to access a piece of software that is out of date and doesn't work. My pieces for electronics performers require the performsers to create their own software solutions to realise the score. Today, they may use Abelton, Pure Data or Max, in thirty years it is likely to be something else. The result is what is written in the score, yet the process of creating that result is up to the electronics performer.

Most of my scores have a few key tenants in common. Pitch is not specified, yet performers must listen to each other so that they may make decisions about a pitch they choose in relation to those around them. The scores are proportional, so for example, if a part is above another part, it should be proportionally higher, and if below a part on the score, lower. Whilst this is not always completely possible, it is an important guiding principle for the works. The acoustic instruments in my electronic/acoustic instrument combinations are never amplified, and any electronic sound should sit within the acoustic chamber setting.

Pure electronic music scores

I don't notate all the music I create, but I do notate works for other electronics performers to play. This has included duos, quartets and orchestras of electronic instruments.

The first of my notated works was *Kingdom Come* (2008) for two electronic performers, inspired by a decade of attending laptop performances. Finding out exactly what individual laptop performers do in performance fascinated me - do they play a pre-recorded track, apply filters or prepare complex interactive programs? *Kingdom Come* provides a range of parameters for the performers, indicated in a greyscale graphic score that includes symbols for 'sound blocks', samples, the movement of pitch, glitch sections, static, ring modulation, delay and dynamics. The score can be seen as a "shell" or action guideline that musicians use to shape their own and live sampled sounds, and interact with them in live performance. As such, the score is not so much about creating sound, but ways to treat it through time [6].

Other works for electronics only include Chrome Arrow (2014), for any four electronic performers and *Bravo Compound* (2015, Figure 1a) for laptop orchestra. *Chrome Arrow* uses a combination of ongoing sounds, increasing and decreasing 'density', glissandi and pizzicato indicators to be interpreted by any electronic group. The premiere of the work in October 2014 was performed on a VCS3, a mobile phone software app, Little Bits and a modular synthesizer. *Bravo Compound* was a much more abstract exploration, restricted to sounds below 200Hz at a constant volume. Opacity was used to signal a different sound textures (dense to thin), hashed designs represented 'noise', and triangles as volume or pitch. The reading of circles are 'realised with a subtle increase in volume, loudest at the full 'height' of the circle, softest at the edge. Sonically, they should represent a kind of 'blossoming' of sound texture, not just volume' [7]. These works are provide the 'shell' described in the instructions of *Kingdom Come*. They provide prompts for electronic artists, but do not dictate pitch or any starting content for the sound, but navigate the performer through the sounds they choose.

Writing for programming

Electronics performers also feature in works for mixed ensembles. The combination of score and instructions enable a programming approach – a patch, sequence, audio file – to be prepared before the performance, and the artist follows the score in the performance alongside the other musicians, to trigger or manipulate prepared material. Most of the works involve some combination of sampling, playback and manipulation.

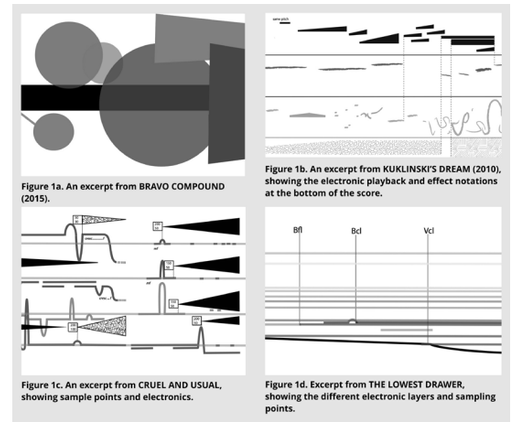

Figure 1. a-d: Notation for *Bravo Compound*, *Kuklinski's Dream, Cruel and Usual,* and *Lowest Drawer*.

The first of these type of scores was *Kuklinski's Dream* (2010) for bass clarinet, cello, viola, carving knives and electronics. The electronics performer has three tasks – record the instruments playing, play back the recording, then playback with effects, where indicated. Long hashed rectangles run under the instrumental parts (Figure 1b), and are shaped for dynamics. In this way, the electronics can be triggered and manipulated in real time. A more detailed preparation is required in *Cruel and Usual* (2011) for string quartet and four bass amplifiers. In this piece, the score indicates a sample moment for each instrument. The sample is given a range in Hertz between which a playback pitch – as sine tone - should be chosen, and played back through a bass amplifier behind a performer, either clean or distorted according to the notation used (Figure 1c). Here, the electronics performer must prepare a system that can sample and playback in real-time, within parameters, for

a certain length, effect and dynamic range. It can be triggered live, or be linked to the digital score playback. The electronics performer makes a pre-programmed or live decision to which amplifier the samples will play back through.

This live sampling approach is also used two other works from 2013, *Sogno 102* for bass flute, bass clarinet, cello, viola, piano and electronics, and *The Lowest Drawer* for bass flute, bass clarinet, cello and electronics. *The Lowest Drawer* instructs the same, realtime sampling of instruments as in *Cruel and Usual*, but the tone plays on through the piece and a 'stack' of tones pile up (Figure 1d). Here, the electronics are notated in colour, and the instruments in shades of grey. In *Sogno 102*, the sampling also occurs, but the tones slowly ascend or descend in pitch. Here, the electronics are notated in the same colour of the instruments, but opaque. Again, these can be manipulated or sampled in real time, or preset as a 'run' program. To date, to my knowledge, the electronics for both these pieces have been preset in Max. But in the future, there may be other program option.

The Theremin has been an important inspiration for my thinking around the notation of electronics, and I undertook a detailed study of the notation for Percy Grainger's *Free Music* Theremin works [8]. I have two works with a notated Theremin part that draws heavily on Grainger's notation – *Empire* (2009) and *Wall Drawings* (2014, Figure 2b). *Kaps Freed* (2017) is a work that uses electronics to create a Theremin sound from the piano. Pitches are sampled from the piano and continued in a Theremin like way. As in *Sogno 102*, the electronics are notated in an opaque version of the colours of the notation for the piano.

A notation for room feedback features in *Majority of One* (2016) and my opera, *Speechless* (2017). In both cases this is notated with a grey sideways triangle, to be read as an increase in volume of the resonant frequency of the room during performance, as in *Sogno 102* (Figure 2a) or after instruments have played, as in *Speechless*.

The only piece I have written for an actual computer program is *Great White* (2016), for two instruments and quintet.net, a program developed by Georg Hajdu [9] In this work, small excerpts of famous historical pieces of music are reproduced in the score – serving not as notation, but rather as a trigger for the midi files of the works, provided to the quintet.net performers to assign sounds to.

The use of pre-recorded material provided as an extra file with the piece is an important part of *Lupara Bianca* (2014) for singing viola performer and electronics. Two files are provided: a recorded gunshot slowed down, and the same slowed down file rendered backwards. The electronics performer decides how to use this material in the piece – all that is provided in the score is the when the sound is played, and the dynamic shape playback it should take. The electronic part for *Wall Drawing* uses a similar notation, but any material can be used (Figure 2b).

In *Erst* (2015), a work for four musicians, synthesiser and electronics, four microphones are placed near performers in the space. An opaque block of colour matching the colour used to score the instruments indicates when the microphone should be switched on and off, diffused immediately after recording (Figure 2c), with an indication in the instructions to 'build up the clouds of sampled sounds over duration of the piece' [10]. Unlike *Kuklinski's Dream*, there is no scored playback instruction.

Some scores simply instruct performers to apply effects to their sound. *Liminum* (2011) for any number of instruments with effects, has a distortion/octaver guitar pedal combination between a microphone on the instrument and a small amplifier next to the performer. Only the effected sound comes through the amplifier, thanks to an on off switch before the other pedals in the effects chain. The effect is written under the instrument part, in a different colour, as a kind of 'underline'. In *Juanita Nielsen* (2012) the amplifier has a simple on and off marking.

Super Scores and beyond

Simon Emmerson uses the term 'super score' to refer to a score that engages the ear and eye together [11]. The Decibel ScorePlayer enables audio to be embedded in the digital score, realising Emmerson's 'super score'. This enables the liver performance to be very accurately linked to the playback. The feature is useful for reading historic works for instrument and tape – the score can pass at the rate that matches the audio file that was once tracked using a clock.

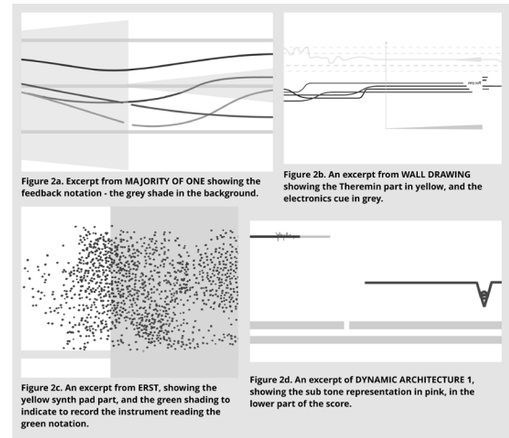

Figure 2a. Excerpt from MAJORITY OF ONE showing the feedback notation - the grey shade in the background.

Figure 2b. An excerpt from WALL DRAWING showing the Theremin part in yellow, and the electronics cue in grey.

Figure 2c. An excerpt from ERST, showing the yellow synth pad part, and the green shading to indicate to record the instrument reading the green notation.

Figure 2d. An excerpt of DYNAMIC ARCHITECTURE 1, showing the sub tone representation in pink, in the lower part of the score.

Figure 2. a-d: Notation for *Majority of One*, *Wall Drawing*, *Erst*, and *Dynamic Architecture*

Signals Drectorate (2014) for any instrument and playback was the first piece to use this feature. Playback is notated on the score as a guide for the performers reference. Audio plays via the mini jack port on the

iPad, and the guide assists in providing coordination between the player/s and the audio. An abstracted screenshot of the audio file as it appeared in the Digital Audio Workstation (DAW) is used to represent the audio – as it gives the clearest 'shape' for the performers reference.
I have a series of works that use very low sine tones embedded in the score. The pitches are presented as long rectangles, arranged proportionally according to pitch as a guide for the performer. Again, these are screen shot from the DAW session used to make the audio file, but abstracted into a light pink shade. This approach is featured in *Dynamic Architecture 1* (2015) for double bass and transducer, with the audio playing through the transducer attached to the double bass (Figure 2d). *Shadow* (2016) for two strings and sub tone, *Pure* (2014 rev 2016) for string orchestra, percussion and sub tone, and *Tone Being* (2016) for tam tam and sub tone all have the embedded audio playing out through a subwoofer speaker.

AM radio static have appeared in several works of mine, notated differently each time. In *Miss Fortune X* (2012), the visual noise on an old photocopy is performed by a.m. radio static, whereas in *Broken Approach* (2014) and *Fourth Estate* (2014) the radio static is indicated by a straight line. In each case, a hand held a.m. radio with a built in speaker is required, and the only instructions refer to volume control and on/off.

Chunk (2011) is a work for Disklavier and a performer on grand piano. This virtuosic piece has two parts to the score – one for the performer, one for the Disklavier. A MaxMSP patch 'reads' the greyscale score for the Disklavier in a man meets machine challenge. Whilst a Max patch was developed for this work, anyone could replicate it – the score for the Disklavier is a score to be programmed.

Conclusion

This article has outlined a rationale and some examples of an approach to notation for electronic instruments in chamber music settings where acoustic instruments are featured. The notation is designed to provide electronics performers with the autonomy to control their instrument in the fashion best suited to them, but also to retain a life for pieces that lasts beyond the life of any operating system or software that may be used to realise the notated electronic contributions.

Biography

Cat Hope is an Australian composer, musician and researcher. She is currently Professor of Music at Sir Zelman Cowen School of Music at Monash University, Melbourne.

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