Electronic Scores for Music: The Possibilities of Animated Notation

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New Scores for Electronic Music: The possibilities of Animated Notation

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Abstract

This paper argues that animated notations are the most exciting new direction for music notation since the conception of the real-time score. The real-time score revolutionized performance practices in new music, with some calling it the 'third way' between improvisation and fixed scores (Winkler 2004). Developing upon the idea of dynamic notation epitomized by the real-time score, animated notation features movement as it's foundation, and may be presented as an interactive program, video or application environment generated in real time or preset. It extends the possibilities presented by graphic notations, engaging the processing power of computing toward new complexities of shape, colour, movement dynamics, form, synchronicity and the very performability of music scores. Beginning with a brief historic overview of trends and background that may have informed the development of animated notation, contemporary practices and their application to a range of music are examined. It is argued that animated notation brings particular benefits for scoring music featuring electronics and aleatoric elements.

Toward a definition of Animated Notation

What is animated notation? Animated notation, or animated scores have been defined as:

"Any score that contains perceptibly dynamic characteristics that are essential to the symbolic representation of the compositional idea" (Ryan Ross Smith 2016),

"Abstract graphics (avoiding images, symbols or pictograms with an inherent meaning) are put into motion for music notational purposes and manifest as fixed media" (Christian Fischer 2015), and as a type of

"'Screen-score' (that) can be one or more photographic images, film or a GUI…usually put into motion by way of software on a computer" (Hope and Vickery 2011).

There seems to be as much debate as there is interest in this question. Building on the recent work by researchers such as Ryan Ross Smith, Pall Palsson, Christian Fischer, David Kim-Boyle and Lindsay Vickery, this paper proposes a definition of animated notation as "a predominately graphic music notation that engages the dynamic characteristics of screen media." Animated notation has the potential to revolutionize notation for electronic performers in particular, as it holds enormous potential to direct and illustrate electronic sound in live performance.

Notation and Technology

The notation of music was the beginning of a musical 'work' existing as something separate from the act of performing, an important development in the way music was created for hundreds of years after that. Music notations have always benefited from advances in technology, and after the printing press, the next biggest development in the realm of music notation was the computer. Printing presses offered the possibility to make duplicate copies and disseminate music faster and

more widely. But the technology of the printing press had its limits. Colour was expensive to mass produce, and fine detail took many years to become a reality. Printed music is not particularly flexible in terms of the way it is delivered to performers. Despite its limitations on the page, traditional music notation has gone largely unchanged for almost 250 years (Fischer, 2015). It served the purpose of depicting melody, harmony, tempo, rhythm, dynamics and structure well. It facilitated different performers playing together in a coordinated fashion. It fared less well in terms of describing textural qualities however – and this became excruciatingly apparent at the advent of electronic music and recording technologies. When tonal harmony began to be pulled apart, traditional notation struggled to adapt there too, and composers stretched it in all sorts of radical directions to compensate (Heathcote, 2010). In my mind, the final blow to the efficiency of traditional, printed musical notation came around the middle of the last century, when a kind of perfect storm was established between new musical sound worlds (electronics), performance approaches (improvisation, cross cultural influences, computer programming) and recording.

When the microprocessor brought on the explosion of personal computing in the late 1970s, followed closely by the inclusion of graphic user interfaces in the mid 1980's, the technology for notation and dissemination of notated music changed again. Computing facilitated approaches eradicated the idea of 'fixed' media – that is, a kind of final and only version of a work - something that had already been explored by artists and composers in experimental music movements such as the 1950's New York School and elsewhere (Gottschalk, 2016). The complexity of open, generative and interactive works developed alongside the rapidly expanding computer-processing power. Yet music notation did not evolve as much as might be expected given these developments. The potential for digital dissemination and

screen presentation of music notations was slow to be realized, despite the impact of computer processing on composition and sound creation. The experiments with open compositional approaches and aleatoric practices that had refreshed an interest in graphic notation in the mid twentieth century did not seem to flow readily into computing in any significant way. Notation programs on computers instead focused on facilitating the creation, duplication, editing and sounding of traditional music notation, with more recent developments seeing tablet computers typesetting hand drawn conventional notation on the fly in programs such as NotateMe. The binding of notation programs to MIDI specifications has also contributed to their limitations. Despite high resolution screens, digital printing processes and multimedia desktop publishing, colour continues to be relatively rare in music scores. High quality audio playback is rarely embedded into notational documents other than for MIDI playback recreations or as part of an interactive programming project. The enormous ongoing struggle over publishing rights has prohibited (legal) fluid distribution of digital scores, and commercial hardware add-ons to facilitate notation rarely goes beyond blue tooth page turning pedals and screen pens. Animated notation has the potential to be the most exciting expanded notational development that links the graphic notation experiments of the 1950s with the possibilities of digital computing.

Music and the art world

Naturally, there is a strong relationship between animated and graphic notations. Anthony Pryer defines graphic notation as a system, where ‘visual shapes or patterns are used instead of, or together with, conventional musical notations’ and separates them into two categories – those that ‘attempt to communicate particular compositional intentions’ and those in which ‘ visual, often aesthetically pleasing,

symbols are presented so as to inspire the free play of the performers imagination in unstipulated ways' (Pryer, 2017). But are the composer's intentions always so binary when creating a score? Cornelius Cardew noted in 1961 that 'A musical notation that looks beautiful is not a beautiful notation, because it is not the function of a notation to look beautiful', addressing a common suspicion that most graphic notations are driven by aesthetic, rather than informational concerns. A brief examination of the relationship of music to art is worthwhile here. The contemporary art climate is an interdisciplinary one, and most freelance musicians work in a range of different musical fields, giving rise to the idea of what Dawn Bennett calls the 'portfolio musician' (Bennett 2014). Various degrees of collaboration across disciplines have become an important element in all art forms, and many individuals trained as classical musicians end up writing for and playing in film scores, works for dance or theatre, game music, curating programs, creating sound installations and taking part in free improvisation. We soak up design and images in this media heavy, visually dominated world. Many musicians transition in (and out) the 'art world', through a variety of projects.

<PLEASE INSTERT FIGURE 1 ABOUT HERE>

Figure 1: Oskar Fischinger (1900-1967), Studie nr. 8, original Animation Drawing

(#2), 1931, charcoal on paper, from the film Studie nr 8. Numbered. The Fischinger Trust, Palm Desert, California, USA.

The genre of Visual Music, a term coined by Roger Fry (1912) to describe what he saw as the 'translation of music to painting' and moving into film, was an early inter-media form that usually involved visual artists working with music, but sometimes the other way around. Projects such as Otto Fischinger's 'ornament sound experiments' and Mary Ellen Bute's 'Seeing Sound' films explored the interaction of the vision and music outside the realm of notation (Brougher et al 2005). These artists were not looking for mechanisms to communicate sound ideas to sound makers; rather, they were exploring the way sound could relate to images. These explorations into a visual language of expression for sound that was not 'music notation' are important, and predate some of the more radical graphic notation experiments that push the boundaries of performability. Recently, books that showcase graphic scores for their pure visual aesthetic have had success, and YouTube is overflowing with 'visual representations' of electronic works. These contribute to an environment of interdisciplinarity, where developments such as animated notation can occur and flourish. Some animated notation exemplars relate strongly to the idea of visual music, in that the scores are film-like in nature, but their intention is often very different. Sáðrás, for toy piano and electronics, made by Icelandic composer and visual artist Pall Palsson in 2013, is a good example. As shown in Figure 1, the score consists of a looped animation where small balls are drawn up to and fall off a shelf inside a large, rotating oblong oval. The performers must choose where to read the score – the moment the balls touch the base of the shape, or as they travel along the shelf or base are two possibilities.

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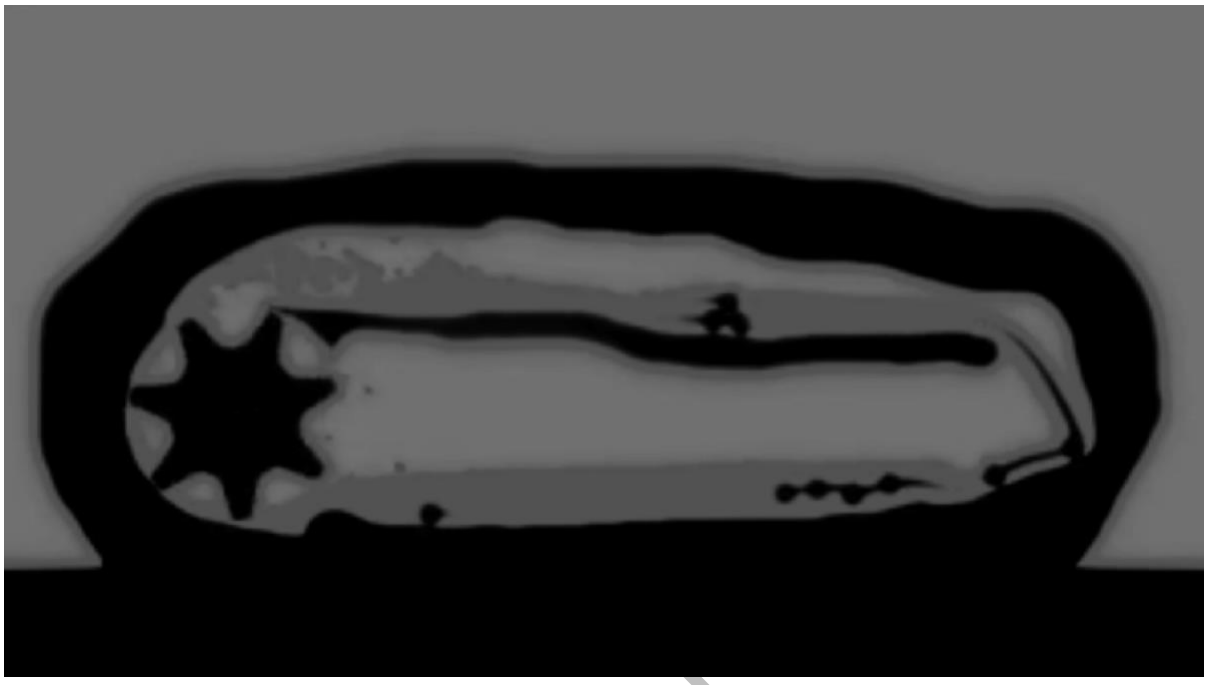

Figure 1: Still from animated score Sáðrás (2013), by Pall Palsson Full video available at https://www.youtube.com/watch?v=7A4z-iXVoiI

Palsson is active as part of a group of composers in Reykjavik, Iceland, that have been pioneering animated notation since 2005, as part a composers' collective S.L.Á.T.U.R. (an acronym translated from Icelandic to "Artistic Organisations Invading Composers Around Reykjavik", but also a food made from the innards of sheep, and literally translating as 'slaughter'). His blog, animatednotation.blogspot.com is a collection of animated notation from around the world that I highly recommend, alongside Ryan Ross Smith's website, animatednotation.com(.)

I compose graphic and animated notation myself. An appreciation and understanding of visual art and film contributes to the design and inspiration for many of my works, probably most literally in a work entitled 'Wall Drawings', shown in Figure 2. It is inspired by Sol LeWitt's Wall Drawing series of paintings, a key series of works where Le Witt's idea's would be executed by artists other than himself,

using instructions provided by him (Reynolds & Miller Keller, 1993). Le Witt was a leading artist of the conceptual art movement, believing the idea itself was the work of art, and that an artist could therefore delegate a project to a construction crew for completion. This approach is at the foundation of my own music, where I assemble a range of information or instructions for the musicians to use to bring the work to its completion, the performance.

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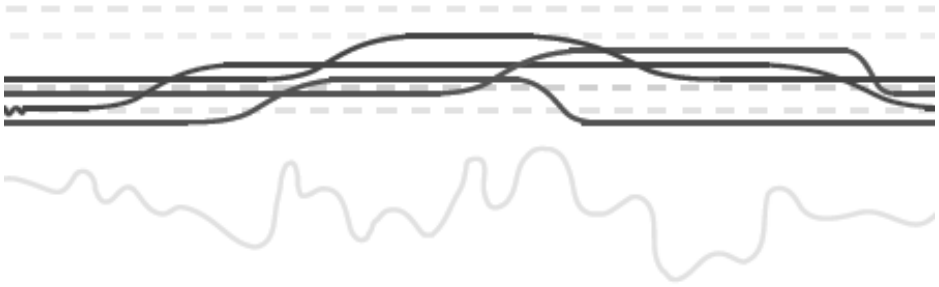

Figure 2: Still from score for Wall Drawing (2014) by Cat Hope. Originally in colour, each line is a different instrument from the string quartet. The lowest, opaque line, is the Theremin part and the dashed lines are guides that refer to the original note played by each instrument. Full score can be seen at https://vimeo.com/134696221

It may be useful to know that I rarely show the scores to an audience, unless it is in a scholarly environment, such as a conference or an artist talk. Showing the score as a piece of music unfolds in performance detracts the listener from the privileging

of sound that a performance of music requires, dividing their attention between the performance and the accompanying visuals, giving away the wonderfully abstract nature of music and its mysterious passage through time. I have no pride invested in the way notations look. They serve a purpose, yet have to be neat to be clear. I stand by my claim that the scores I make are created primarily and fundamentally to transmit information to performers. I do make choices about characteristics of the score that are not driven by any sonic imperative, such as the colours I choose, so I cannot claim that I ignore the aesthetic qualities of the notations either. I think most composers of animated notations would acquiesce to this to some degree. This is an interesting issue around that nature of animated notations that merits further investigation beyond the scope of this paper.

Real Time Composition and Aleatoricism

The definition of animated notation I provided earlier is not dissimilar to Clay and Freeman's definition of real-time notation as "any notation, either traditional or graphic, which is created or transformed during an actual musical performance" (Clay & Freeman 2010*)*. This is largely because the impact of interactive programming environments have led to a range of possibilities for music composition. In addition, elements of improvisation and a broader acceptance of aleatoric aspects in music have been crucial to, and even nurtured by, digital processes. Chance can happen at a range of different stages in a work – at the composer's conception, the performers realisation or both, and on different points on that scale. Real time composition focuses largely on the compositional process, with computer programs often set to provide a range of choices that lead to diverse outcomes. These outcomes might take the form notation generation, the application of sound effects, or the triggering of sound stored within the program. Importantly, these kind of processes can be

executed both in real-time or as triggered presets. That is, the outcome of the process maybe known, or unknown, at each iteration of a work, depending on the composers' intentions. Thor Magnussun (2011) proposes that the programming interface in computer music can be thought of as a kind of score. But this kind of score can only describe processes as they are occuring, rather than enable a new reproduction of the work as a result of this score. Given the rapid evolution of software and, to date, a frequent lack of support for superseded versions of soft and hard ware, I would argue a notated score, other than the interface of the program itself, is required to communicate the desired aim of that program. If the composer wants the work to remain performable beyond the life of the tools engaged to create its early iterations, or beyond constant updating whilst the composer is still alive, I believe a score is necessary. It should provide conceptual information that outlasts any computer program, and enables a repeat performance despite technological variables.

How much, and what kind of information is required in a score to enable such an accurate reproduction? This question is of course not a new one, but it is a relevant one to consider when discussing the nature and intention of animated notation. Scoring any kind of generative work in way that enables an accurate reproduction of said work is a significant challenge. I believe that creating a score at the conceptual stage of the work, as a guide, rather than a summary, for a performance outcome provides valuable documentation to enable repeat performances. Aleatoric aspects can serve certain requirements of the composer, and can be built into notations so as to reflect some of the chance procedures that are a feature of computer programming for music.

The challenges of notating electronic music

Despite a surge of artists embracing electronic music both as composers and performers, the recourses for notating electronic music remain relatively limited. As is the case with most of the examples I will provide here, electronic performers often find themselves interpreting works for open instrumentation. Whilst attempts to notate spatiatlisation and use graphic scores to assist the analysis of electroacoustic music have had some success, specific notations intended for electronics are actually remarkably rare. Electronic music has brought about a different time-space dimension for music, moving emphasis way from metrical restraints and toward proportional parameters (Ross Smith 2015). This emphasis is well served in animated notations, where motion can illustrate the shifting proportional relationships through time.

<PLEASE INSTERT FIGURE 3 ABOUT HERE>

Figure 3: Still from the score by Ryan Ross Smith, Study no. 17 (2013). See a demonstration animated score at https://youtu.be/P_4vcdrKwnY

Laptop orchestra's have been pushing notation for electronic music in different directions, and often incorporate instruction for physical gesture. Ross Smith's Study No. 17 (2013) for the laptop orchestra PLOrk is a score that is also the sounding piece, shaped by the performers, and an excerpt is provided at Figure 3. The laptop performers each have a copy of the score application, and listening to each other is a key methodology for the success of the piece, as the performers move shapes with the cursor to create different sounds. This requirement for a refined sense of musical listening means animated scores are not an 'easy option' for composers or performers, and a reason why they are not always ideal tools for teaching music either. A trained music ear is key requirement to facilitate the proportional pitch relationships in the works, where parts come together and move away from each other.

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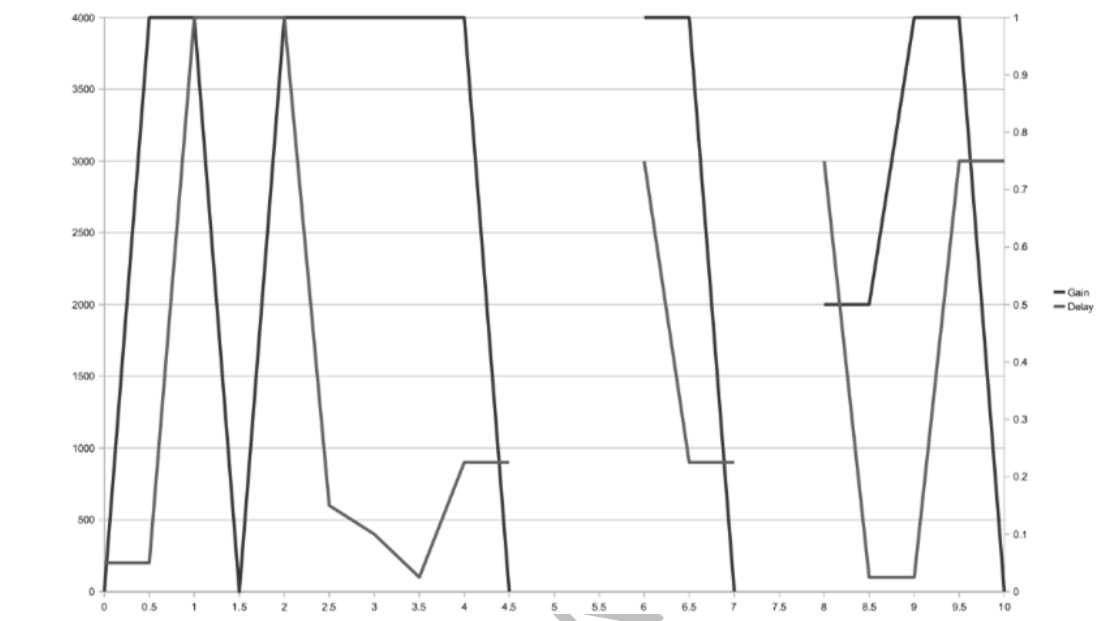

Figure 4: Score to Scott Hewitt's 'Feedback Slide' (2012), originally in colour to differentiate different parts.

Scott Hewitt's 'Feedback Slide' (2012) for laptop orchestra is not an animated notation, but addressees some of the issues around scoring and performing electronic music. The score, shown at Figure 4, provides literal slider instructions, leaving the movement pace and speed of the slider motion up to the performers. Hewitt expresses frustration at extant notation paradigms for computers, saying that the composer is forced to opt for either precision in a limited number of parameters, or a broader direction of intent (Hewitt 2012). He goes on to question the need for performance at all, if the machine could be programmed to do what the composer wishes. This is a common concern in electronic music, which many laptop orchestras attempt to address by focusing on bodily movement, rather than mouse or joysticks, for control by using Wii and other hardware controllers that provide dramatic,

performative effect. The Stanford Laptop Orchestra's (SLOrk) performance of Ge Wang's piece Twilight (2013) at the Bing Concert Hall at Stanford University that year is an excellent example of kind of choreographed performativity. This 'liveness' that is so seductive in performance is also a key element pf improvisation, and therefore of all graphic notations and animated notations that require improvisation as part of their interpretation. But that's not to say animated notations can't or shouldn't be rehearsed: performers can learn from examples of previous iterations of scores, and usually have instructions to assist them decode and memorize symbols, which may be common to other works by the same composer.

My own composition work began with a desire to empower electronic music performers with scores that enable them to make choices about how best to engage their instrument, just as other musicians do. I wanted them to have an similar role to other musicians in a mixed ensemble. This means that that notations will not necessarily always detail the actual sound, as you may take for granted in notations for a flute, for example. More often, notations provide parameters for sound choices. My scores describe what the electronic musician, should do, not how they do it, or on what program.

What follows are three examples that explore these attempts at notating for ensembles with acoustic and electronic musicians, that involve live sampling and playback during performance. The scores are fixed, not generative – their motion is a way to enable their coordinated reading. Each of these scores is read using the Decibel ScorePlayer, an iPad software application that moves the score from right to left at a speed determined by the composer, providing a fixed vertical 'playhead' to coordinate the performance point of the performers throughout the piece (Hope et al, 2015). The application was devised by the ensemble that I direct, Decibel, in 2012, after some years modeling the 'scrolling' presentation technique in MaxMSP (Decibel

ScorePlayer, 2012). Multiple iPads can be networked together, and the score can consist of a single image, or the image and a series of parts. The playhead idea is not new - it is also used as a tool for following traditional notation (as can be seen in programs such as InScore) and is the default way to orientate listening in most audio editing programs. In the 2000s, a few artists were experimenting with this playhead idea as a way to track all kinds of scores, even if the 'playhead' was just the left hand side of a video screen.

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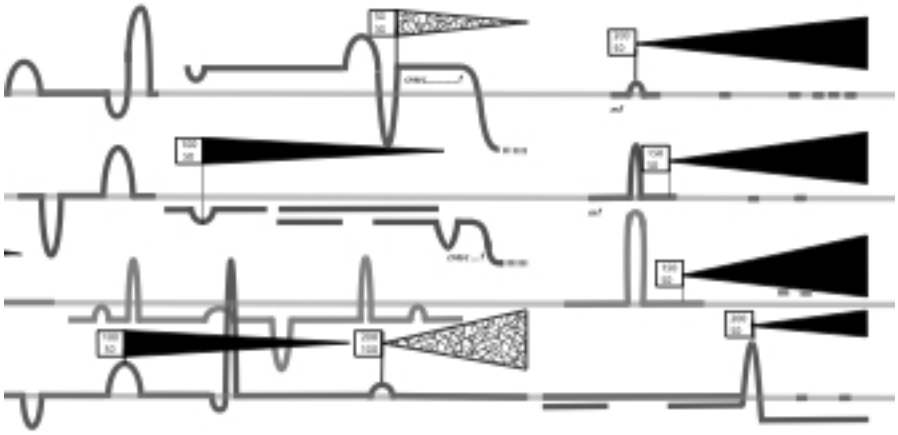

Figure 5: Still from Cruel and Usual (2010) for string quartet and electronics, by Cat Hope, originally in colour. Full score available at https://vimeo.com/91175555

Figure 5 is an excerpt from Cruel and Usual (2010) for string quartet and electronics. Each string instrument is represented by a unique colour and are represented ont the score from top to bottom as violin 1, violin 2, viola and cello. Each instrument has a baseline pitch (the horizontal straight lines) to which they refer to proportionally throughout the work, but parts do not relate proportionally to each

other, in this case. The sideways triangles are the electronic parts, linked to the different instruments which each have a pick up running to a record enabled computer program which processes the sound at certain points in the score, and sends it back out to a bass amp behind each performer. Each instrument is sampled where notated on the score, where it is recorded for a fraction of a second, and the sample then transposed immediately to a pitch selected by the electronic musician (or automated by them) from within the range provided on the score. The sample is played back immediately as a continuous sound through their bass amp at the length, dynamic and textural shape indicated by the sideways triangles. Black is a clean sound; the hatched effect indicates a distorted sound, the nature of which should be chosen by the electronics performer. The widening and thinning of these indicate the dynamic ranges. This play back creates layers of sound that lay alongside the acoustic instruments, creating dense gestural components that originate from them, and differ in each performance, as the original pitches chosen by the string performers each time will be different, as will the choice the electronics musician make within the pitch range vary.

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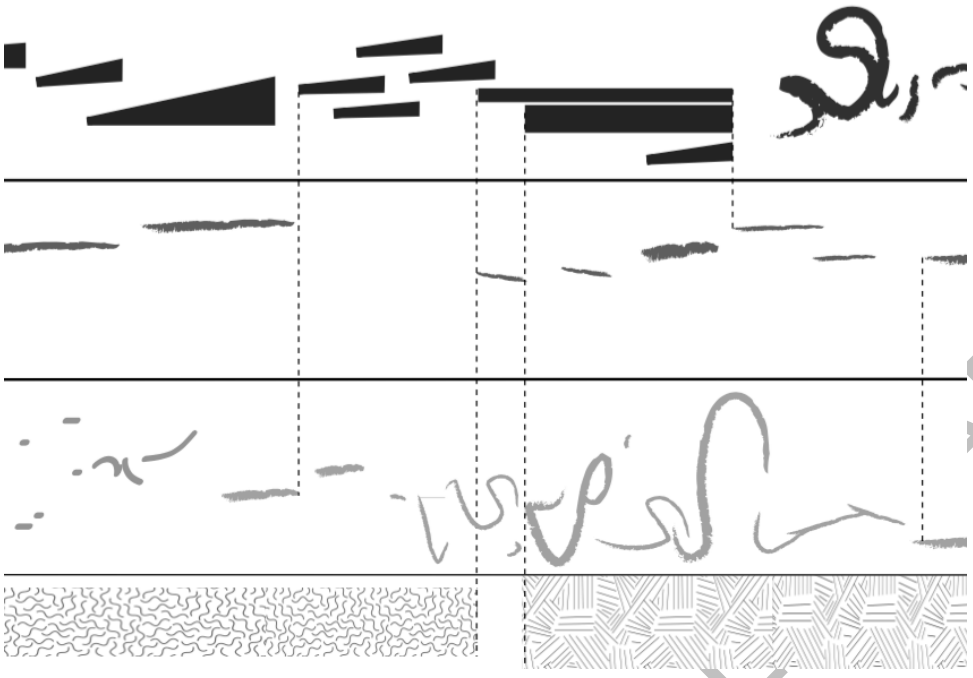

Figure 6: Still from Kuklinski's Dream (2010) for three instruments, carving knives and electronics by Cat Hope, originally in colour. Full score available at https://youtu.be/JU2_Bnd6DiQ

An excerpt of Kuklinski's Dream (2010) for three instruments, miked up/bowed carving knives and electronics is shown at Figure 7. The three instruments are separated by the horizontal lines, which serve to outline the pitch parameters for each acoustic instrument. The bowed carving knives have their own notation that is not featured in this excerpt. The textured part at the bottom of the score is the electronic musicians part. The hashed vertical lines are provided to assist coordination of the performers. There are three textures uses in the piece - one texture designates recording of all the instruments during the time specified, the other designates the playing back of the unaltered recording made, and the third texture indicates playing back the recording with effects chosen by the electronics performer. This excerpt shows the playback and effected textures. They provide enough information for the electronics performer to understand how they should

interact with the live instruments, but it does not provide detail of how to interact. For example, they may choose to only record one of the instruments, or to record each instrument from a different distance. They may choose from any type or mixture of electronic effects to apply, and choose the level of saturation. The composer denotes a point in time for these actions to occur, that determines the formal shape of the work, but the details lie with the musicians.

<PLEASE INSTERT FIGURE 7 ABOUT HERE>

Figure 7: Still from Erst (2015), for five instruments, synthesizer and electronics by Cat Hope, originally in colour. On the lower left is some of the synthesizer part. The different shades of 'dots' are for different instruments, playing these pizzicato-like notes. An iteration of the full score available at https://vimeo.com/139556204

Continuing on this 'zone' of recording idea, my work Erst (2015) for five instruments, synthesizer and electronics, of which an excerpt depicted in Figure 7, includes a part for a 'spatialising' electronics performer in the ensemble. Each

instrument here has its own colour, and the pizzicato clouds are derived from bee swarm activity. All instruments are set to be recorded individually by the electronics performer. When the score page is covered in an opaque colour panel, the microphone for the corresponding instrument (that reads the pizzicato notation of that same colour on the score) is activated and the section recorded. It is then played back through a speaker in an array of the operators' choice when the opaque colour panel no longer appears. Sometimes, the colours overlap; meaning two instruments may be recorded at once. Each iteration of the score is unique as the coloured panels appear in different places each time. Snatches of live performance are repeated, layered and slowly engulfed by others. As the piece develops, the texture of the recorded material thickens and begins to overpower the acoustic instruments, which are not themselves amplified. New arrangements of sounds emerge from these combinations of recordings in space, their movement designed and controlled by the electronic musician in real time. The pointillistic texture in the score creates a timbral and textural quality that defines the piece, even if performing it accurately is not entirely possible. There are often too many pizzicato notes for one player, so they need to choose how best to represent the cloud effect on their instrument. Even so, the work is easily identifiable each time, despite the amount of free choice in each reading.

These scores for Cruel and Usual, Kuklinski's Dream and Erst clearly communicate the intent, function and placement of electronics in the works, and the electronics performer can use whatever program is available or familiar to themto execute their part. Each time the pieces are performed, results will change, because the score leaves many choices for the performers. However, the information in the score is enough to enable these works to be identifiable as the same work despite who performs them, what choices they make or processing they choose.

These works above are very two dimensional, and both Cruel and Usual and Kuklinski's Dream could be read from a video file if need be. But Erst demonstrates a range of aleatoric elements at play in the way the score assembles itself. This means there is no one final version of the score, only iterations – a substantial conundrum for notation that aims to preserve a work into the future. Erst is programmed to enable the score to appear differently on each animated iteration. Animated notations can facilitate and embed the link of programming to notation.

Beyond the Two Dimensional and the 'Right to Left"

Generative animated scores provide a range of possibilities that relate directly to Freeman's composition idea of constructing components of the score in real-time. Winkler (2014) compares real-time time scores to TV or a movie, paving the way for thinking of scores as moving with the fluid motion of a video. He refers to 'new possibilities of control' where the responsibility of the composer is not lost, but changed from a builder to what he calls a 'creator of potentialities' (Winkler, 2014). Eric Maestri proposes a topology of notations that draws on the perspective of their performance, dividing notation in to past, present and future types. The past involves the reconstruction of something past, such as a recorded sound event. The present is a performative one, where the performance in real-time defines the meaning of the score. The future is represented by traditional notations, that hold all the information required for a relatively accurate performance (Maestri 2016). Animated scores that engage real-time composition sit in the present – decisive events unfolding as the performance takes place, as well as the future, providing information for performances yet to occur - breaking apart this three way division.

A common trope for computer driven composition is the idea of a notation 'grab bag' – where the computer retrieves different notations stored in the program or desktop and presents them on the screen to be performed. Animated notation provides a streamlined alternative to this approach. Generative animated notation – images generated in real time to be read as instructions for music making - binds the score more closely with the computer processing that may be occurring in behind the score presentation. David Kim-Boyle and Pedro Rebelo each provide interesting generative works that operate in a deeper, more three-dimensional space of notation.

<PLEASE INSTERT FIGURE 8 ABOUT HERE>

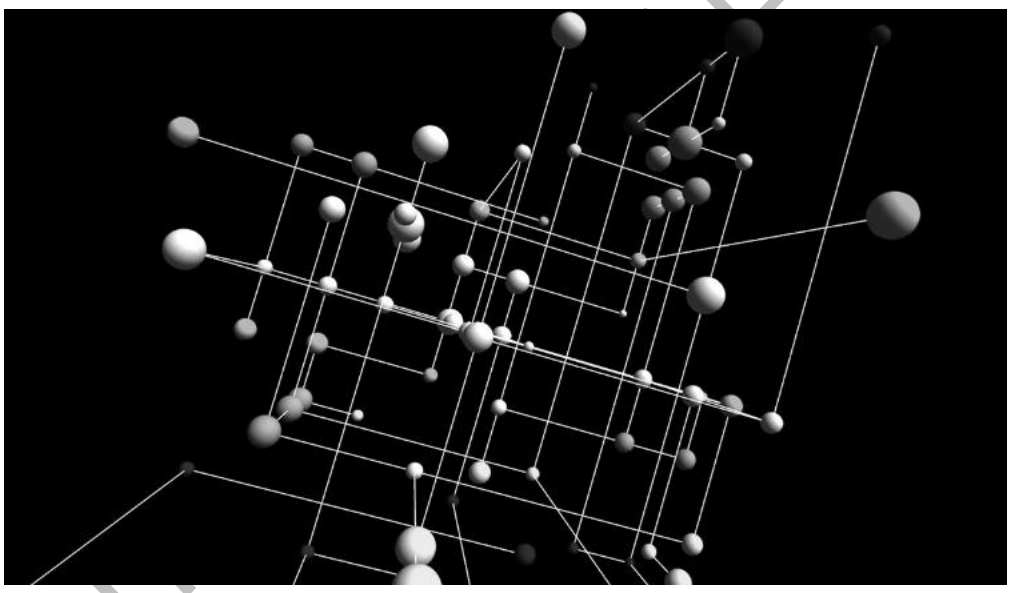

Figure 8: Video still from the animated notation score for David Kim-Boyle 'point study no.2' for two instruments and electronics, originally in colour. An exemplar score can be found at http://www.davidkimboyle.net/point-studies-no-2-2013.html

David Kim Boyle's point studies No.2 (2013) for two instruments and electronics is constructed and performed in MaxMSP, the program that generates an audio part and a score. A still from the notation is at Figure 8. Two performers are each

assigned their own slowly rotating image, read coloured nodes which have pitches ascribed to them, the changing sizes of these nodes as dynamic information, and the connecting lines as the duration guide for each pitch before it changes to the next. Kim-Boyle refers to scores like this one as 'kinetic structures', as they constantly move and evolve (Kim-Boyle 2010). The score material and the audio playback – created in real-time - are intrinsically linked and inseparable. The piece creates a dreamy, almost formless quality that is not unlike ambient music. Yet it is fully scored, providing an environment in which the performers choose from materials provided to them. This is an example of animated notation's ability to provide a 'scope' of choices within a piece, and the movement of the score is replicated in the sound of the music; slow, smoothly layering parts that meld with the sine tone electronics parts.

<PLEASE INSTERT FIGURE 9 ABOUT HERE>

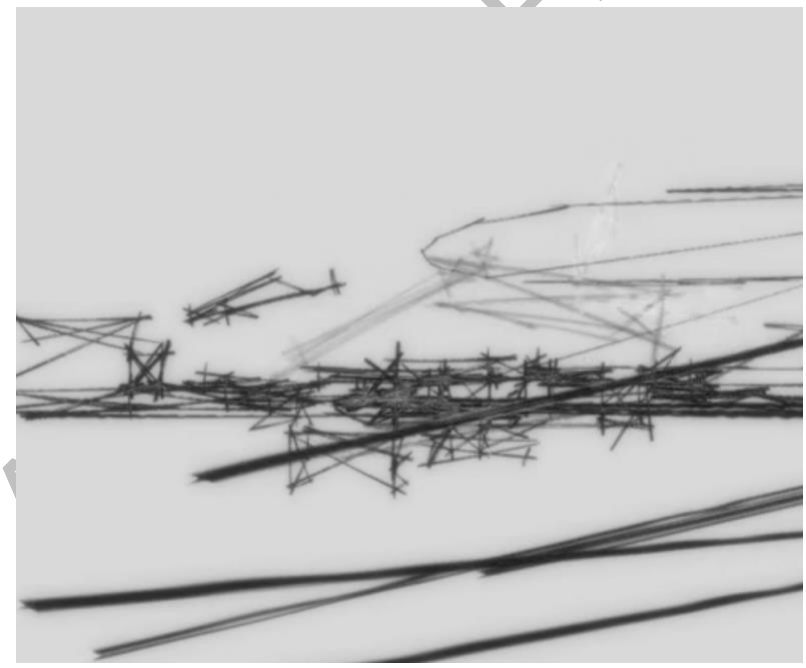

Figure 9: Still from demo for Pedro Rebelo 'Netgraph' (2010) originally in colour. To see the animated score go to https://vimeo.com/48799080.

Pedro Rebelo's score for Netgraph (2010), as seen in figure 9, uses PlaySpace – a real-time graphics rendering engine developed by Rebelo and Rob King (Rebelo 2010). Netgraph is a piece whose score is designed to be read in a networked performance, with musicians in different countries reading the score, where objects in three-dimensional space are read from different perspectives in the different locations by both the performers and the audience. The movement of the score enables this engagement from different points of view in real time, a possibility difficult to image without the animation of the score.

Whilst animated notation embraces both real-time and fixed notational practices, and can facilitate scores for networked performances as in the Rebelo example above, it almost always embraces a larger degree of aleatoricism than most other notations. It is important here to differentiate aleatroic elements from a 'free for all' or 'guided improvisation.' Such scores can leave some choices to the performer, but are very clear and precise about others. Again, there is a range of freedom for each element of the composition at different moments in its formation and performance. Below are some examples of how this range may be articulated or framed.

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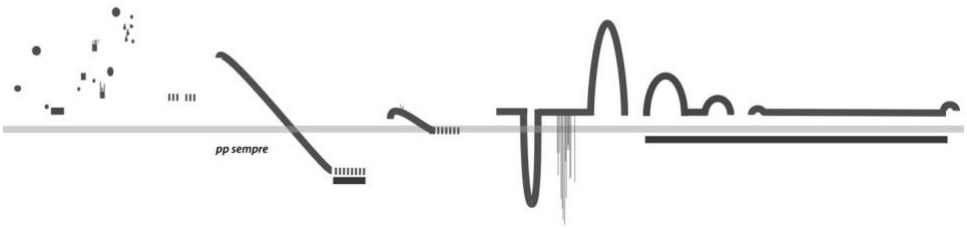

Figure 10: Still from Liminum (2012) for any group of similar instruments with electronic effects to bass amplifiers, by Cat Hope, originally in colour. An iteration of the full score available at https://youtu.be/a8kPnVyKn00

Explorations of pre and post performance aleatoricism are common in animated notations. Figure 10 shows an excerpt of Liminum (2012) for any group of similar instruments with electronic effects to bass amplifiers. I wanted to disrupt the forward motion of the score as part of the pieces' compositional framework. As with any other kind of real-time composition, there is no 'final' version of the work, just a template that is cut up and reshuffled into a different order of materials for each performance. Liminum is a work that starts simply scrolling left to right, but then is disrupted by jumping to different, randomly chosen parts in the score several times. Each performers ipad starts and progresses through the piece in unison, and each performers' score will disrupt in the same place at the same time, but jump to a different point in the piece for each performer. There are a range of places I have marked for the score play head to land, as can be seen in the upper part of Figure 10. The selection of either forward or backward motion is a computer choice. This

disruptive activity is bookended by ‘unison’ material. However, each performer plays the unison material using any pitch in which to do so. The ‘harmony’ is created completely by chance, and the starting pitch each performer uses is referred to throughout the score with a grey horizontal line, as in the Cruel and Usual example earlier, to assist the performer to orientate their pitch choices against the note they chose at the beginning.

Other works use computer processing in more fluid notation environments, creating some of the most innovative of the animated notations. These can be notations engaged to realise electronic music, acoustic/electronic combinations or to instruct any kind of instruments. The Ryan Ross Smith excerpt shown in Figure 11 provides a good example of the latter.

Figure 11. Still from Ryan Ross Smith. The original has some colour.

This work is developed in the program openFrameworks, an open source C++ tookit. A very prescriptive and active kind of ‘avatar’ literally draws connections between what the performers play. The performers learn a library of sounds but the order of the sounds will be different each time, and the performers are required to move between one sound and another very quickly, picking up on Freeman’s

'extreme sight reading' notion (Freeman 2008). Yet the piece sounds remarkably static to the audience, with a sense of flatness or formlessness, and an arbitrary ending where the piece just seems to cease - not unlike a merry-go-round that keeps turning until you decide you want to get off. The score is sometimes delivered as a rendered video version, so whilst the work assembles in real-time, the performance of it does not necessarily happen at the same time. This is addressed by Ross Smith undertaking a kind of editioning, by releasing videos of score iterations with unique catalog numbers.

Bringing history into contemporary practice

John Cage pioneered different elements of aleatoricism in his series of eight works entitled Variations (1958 – 1967 (revised 1978), as well other works. Variations I (1958) for example, requires the performer to assemble the score beforehand, but then play it as a fixed, finished score, providing a kind of reading. That reading is only fixed and finished for that performer, at that performance. If they do not like the result, they may even reassemble the materials and create a different version. The Decibel team developed another score creator application for the complete set of Cage Variations I – VIII that digitally renders the organization and reading of this assemblage instantaneously, and more accurately (Hope et al 2013). The graphic representation, as seen in Figure 12, derives from conventions of other graphic scores around the time the work was composed, and put these conventions into motion for a more coordinated performance. Height being pitch, width being volume, shade being textural density, length being duration – these are almost standards in graphic notation (Hope and Vickery 2011). Each 'reset' of the application, using the button at the bottom left corner of the program seen in Figure

12, creates a new instantiation. The works are of open instrumentation, meaning that any performer (acoustic or electronic) can interpret them.

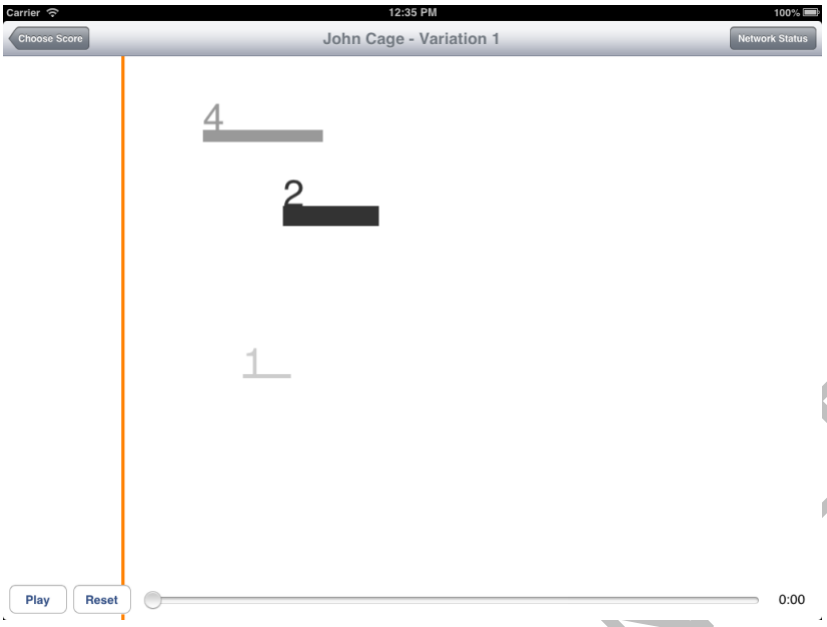

Figure 12. Still from one iteration of John Cage Variation No. 1 (1958) as it appears in the Decibel score player application, 'The Complete John Cage Variations'.

Cage provides an example of how the dynamism of animated notation has been pioneered through history. American composer Earle Brown, whose explorations with 'mobile forms' and 'mobility of elements' forms an important starting point for dynamic notations that differs from the video experiments of visual music mentioned earlier. Inspired by connections with the art world, in this case most importantly Alexander Calder's mobiles, the New York school pushed musical ideas and notations in different directions. In fact, it is worth noting that Brown did discuss ideas for a motorized installation version of his important graphic score December 1952 in his written reflections on the work (Brown 2008). Brown saw the possibility for a more urgent and intense collaboration with performers as both an aim and result of dynamic and changing musical forms and relationships. Another important

and underestimated pioneer is Percy Grainger, whose notated Free Music works (1936 – 1938) are some of the first graphic notations in the twentieth century (Gillies 2011). These are works inspired by movement, and scores, which were created as curves on graph paper, could be more accurately performed if they were in fact animated, drawing attention to the possibility for animated notation to provide a more accurate reading of works of the past. This principal can also be applied to the bountiful works that exist for instrument(s) and stereo tape, which can syncronise the audio with the score through time. Decibel member Lindsay Vickery created a version of Denis Smalley's 'Clarinet Threads' (1985) for the Decibel ScorePlayer that eliminates the need for a stopwatch - or memory, to play the piece. The Decibel ScorePlayer enables sound to be embedded into the score files, and so any works that have a stereo playback can be re-published as a digital score where the audio and score are lined up precisely, as in this example.

Conclusion

What Rebelo calls 'iterative interpretation' and Ross-Smith calls the 'field of possibilities' are key musical characteristics of works composed using animated notations. What Haubenstock-Ramati sought as 'discovery of material' and 'invention of form' (Haubenstock-Ramati 1965) is being built upon in the evolution of animated notations.. An ever expanding range of media that can enrich software score files means that scores need no longer remain static flat objects, but can come alive with embedded control messages and audio. The electronic and notated parts no longer need be separate. This has as much importance to the preservation and ongoing engagement with music from the past as it has with music yet to be made. Moving through time, or scattered across it, across time zones and physical landscapes –

animated notations can assist us to challenge our perceptual notions of time for music and sound more generally.

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