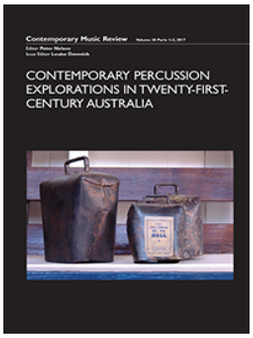

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Expanded Percussion Notation in Recent Works by Cat Hope, Stuart James and Lindsay Vickery

Lindsay Vickery, Louise Devenish, Stuart James and Cat Hope

This paper discusses the percussion notation of Western Australian composers Lindsay Vickery, Stuart James and Cat Hope. Both the compositional and performative aspects of their notational conventions are considered in the diverse approaches they take to the specification of timbre, improvisation, and ensemble coordination. The design and interpretation of screen-based technologies, tablature gestural approaches and spectrographic notation is explored using Lindsay Vickery's The Miracle of the Rose *(2015)* InterXection *(2002) and* Lyrebird *(2014), Cat Hope's* Broken Approach *(2014),* Sub Aerial *(2015), and* Tone Being *(2016) and Stuart James'* Kinabuhi | Kamatayon *(2015) as case studies.*

Keywords: Notation; Percussion; Gestural Notation; Tablature; Screen Score; Musical Co-ordination

1. Introduction

The timbral pallet employed by composers and performers has expanded exponentially since the end of the common practice period. Ideological shifts and technological advances, including the embrace of noise in Futurism (Russolo, 1967), of all sounds in indeterminacy (Kostelanetz, 1988, p. 42), *musique concrète* (Palombini, 1993, p. 14; Poullin, 1957; Reydellet, 1996), *musique concrète instrumentale* (Lachenmann, 1996, p. 212), free improvisation (Bailey, 1993) and spectral instrumental synthesis (Grisey, 2000) have driven aspects of the art towards increasingly detailed sonic exploration. At the same time, adoption of these practices has undermined domination of the rigid pitch and rhythmic grids of equal temperament and metrical subdivision found in traditional notation. These transformations have particularly influenced the

notation of percussion music, as the definition of a 'percussion instrument' is uniquely broad, encompassing a wide range of instruments and objects, and further diversified by a range of performance practices characterised by the exploration of sounds produced through striking, shaking, stirring or stroking. As a result of the myriad of sonic possibilities produced under the banner of 'percussion', questions of notation are inevitably raised when it comes to committing new compositional ideas and performance practices to paper.

Developing a practical notation system is an integral part of the process of creating a new percussion work comprising a collection of either untuned or unconventional instruments, termed *multi-percussion*. The lack of a standardised notation system for multi-percussion repertoire has been a subject of debate and scholarship since solo percussion works emerged in the mid-twentieth century. At present, various forms of altered traditional Western notation, line notation, pictographic, text-based and hybrid forms are used across the percussion repertoire (Betts, 2010; Schick, 2006). The advancement of screen-based notation software over the past two decades has enabled development of scrolling, animated and interactive notational forms (Hope & Vickery, 2010; Hope, Wyatt, & Vickery, 2015; Wyatt, Hope, & Vickery, 2013), providing further means of presentation for percussion repertoire. The range and combinations of novel notation used globally by composers when writing for percussion demonstrates that although no dominant form or standard for percussion notation has arisen, what *has* become standard is the development of notation uniquely suited to the technical, physical and musical demands of any given new work.

Since 2000, the creation of new works for percussion has become a prominent fixture of the Australian contemporary music scene, as increasing numbers of performers, sound artists, improvisors, ensembles and composer-performers refine arts practices rooted in contemporary percussion music (Devenish, 2015). In recent years, technological advances have enabled artists to produce a diverse range of experimental percussion works requiring unique notational systems to express and document new ideas. This paper discusses the varied approaches to percussion notation by three Western Australian composers: Cat Hope, Stuart James, and Lindsay Vickery. The compositional and performative aspects of their notational innovations, ideologies, and technologies are examined using examples from works composed almost exclusively between 2014 and 2016, as shown below in Table 1.

Thematically, the compositions in Table 1 reflect a multifarious approach to composed percussion music, each dependent on the context of the composer–performer relationship. Each work was composed as a part of a recital that featured new works in relatively underrepresented areas of Australian percussion music such as percussion-theatre, duo percussion, and experimental music. The works range in duration between 10 and 18 minutes, and several have variable durations as a result of their exploratory nature. Furthermore, in several works, the instrumentation is dependent upon the choices of the performers for whom the work was composed. Together, these works offer a snapshot of different notational approaches found in Australian

Table 1 Percussion works composed by Cat Hope, Stuart James and Lindsay Vickery between 2014 and 2015.

Composer	Work	Duration	Instrumentation	Commissioner
Cat Hope	*Broken Approach* (2014)	12′	solo: bass drum kit, a.m. radios and wind-up mechanisms	Vanessa Tomlinson
Cat Hope	*Sub Aerial* (2015)	15′	duo: variable	The Sound Collectors
Cat Hope	*Tone Being* (2016)	13′35′	solo: tam tam and subwoofer	Louise Devenish
Stuart James	*Kinabuhi* | *Kamatayon* (2015)	18′	solo: reyong and bonang gamelan and live electronics	Louise Devenish
Lindsay Vickery	*Lyrebird* (2014)	variable	variable	Vanessa Tomlinson
Lindsay Vickery	*The Miracle of the Rose* (2015)	10′15″	duo: 2 cymbals, 2 vibraphones and 5 objects	The Sound Collectors

percussion music composed within the last decade, including adaptations of common practice notation (CPN), tablature or gestural approaches, graphical notation and hybrids of these forms. These approaches will be discussed in the following paragraphs, using the above works as case studies.

1.1. *Historical approaches to percussion notation*

Although percussion instruments became a staple of European orchestras as early as the eighteenth century, notational representation of percussion instrument parts developed slowly. Initially, timpani parts, for example, were not included in the orchestral score 'since it was assumed that the music for this instrument could be "created" by the performer based upon the trumpets' music' (Bowles, 1991, p. 429). This practice highlights the sense of 'otherness' that percussion instruments and performers have long held in a Western art music context. When percussion notation began to appear in orchestral scores, it was initially based upon the traditional five line staff known as CPN. CPN matured around 1600 in parallel with other conventions of the European common practice period (Boone, 2000). As compositional practices in Western art music have evolved the limitations of CPN for representing music that explores concepts, sonic parameters, performance practices and instruments beyond the common practice period have emerged. These limitations have been probed in a range of literature (see Brown, 1986; Cassidy, 2013; Clayton, 1996; Erickson, 1975; Hope & Terren, 2016; Keislar et al., 1991; Kojs, 2011).

The advent of solo percussion works in the 1950s such as Karlheinz Stockhausen's *Zyklus* (1959) and Sylvano Bussotti's *7 Fogli, No. 2 'Coeur Pour Batteur'* (1959) also marked the beginning of a revolution in percussion notation. In both works, CPN

clefs and staves remain but are used in conjunction with new idiosyncratic graphical symbols (*Zyklus*) or radically deconstructed shapes (*Coeur Pour Batteur*). The idiosyncratic nature of instrumental requirements and variety of means of playing them leant itself to the invention of new notational vocabularies. Semantic principals were often employed in these new forms of notation. For example, Stockhausen denotes changes of intensity in *Zyklus* by varying the thickness of the points and lines (Lambert, 1983, p. 17). Pictographic symbols were also commonly used to specify physical objects such as sticks, mallets and instruments (Williams, 2001). What is conspicuously absent from a number of these novel notational systems was the grid CPN normally provides for specifying metre and/or rhythm.

By the mid-1960s an ad hoc approach to percussion notation had emerged. This continued until a flurry of articles in the late 1960s by percussionists (Caskel, 1971 DeFelice, 1969; O'Connor, 1966; Reed & Leach, 1969) led the Percussive Arts Society (PAS) to attempt to codify and regulate the practice in the report *Standardization of Percussion Notation* (1973) and its follow-up *Symbols for Percussion Notation* (McCarty, 1980). However, these attempts at standardisation are of their time and were not widely embraced. One of the reasons the standardisation of notation was not pursued is the variability inherent in any percussion work. Due to the wide-ranging instrument collections of individual performers, the particular instrumentation any single percussion setup is almost infinitely variable, and individual interpretations of repertoire can vary significantly. Furthermore, on occasion individual percussionists have re-notated scores when their preferred spatial layout of instruments renders the original notation counterintuitive. An early example of this can be found in Chester's 1987 publication of a revised score for Stravinsky's *Histoire du Soldat* (1918), in which the five instruments—each notated on a separate staff—were condensed onto a single stave by percussionist James Blades (Smith, 2005, p. 27). A more compelling reason the standardisation of percussion notation was not pursued by practitioners is the rapid rate of growth and exploration in contemporary percussion music. In the 1970s and 1980s, contemporary percussion music was still emerging and coming to terms with its global identity. The field has progressed exponentially in the decades since. Attempts at standardisation of notation that could place perceived boundaries around certain approaches to percussive music making have been largely abandoned. In Australian percussion music composed since 2000, a range of paper and screen-based forms of notation are prevalent. Across both forms, adapted CPN, tablature/gestural notation, graphical notation and text-based scores are common. The following paragraphs demonstrate examples of this notation.

2. Extending CPN

Composed for Louise Devenish, Stuart James's *Kinabuhi | Kamatayon* (2015) is an example of a recent solo work that has adapted CPN to depict a hybrid percussion setup, in this case, a set of Balinese and Javanese gamelan gongs. Given the work largely explores rhythmic materials in canon, as well as larger scale metric and

tempo relationships, a system of notation that draws on CPN would seem appropriate. This form of notation communicates not only the composed rhythmic and metric relationships, but also allows these underlying structural relationships to be explicitly presented to the performer.

The work was developed over a twelve-month period, commencing with a series of workshops to explore instrumentation and performance techniques. The instrumentation in this work is comprised of 10 individual gamelan gongs, selected to form a particular pitch set. Discussion of the staff layout for this pitch set was ongoing through the workshop process associated with this work, as the notation was initially based on the depiction of compositional gesture and idea, and was later modified to improve performer readability. The final staff layout (shown below in Figure 1) is arranged in such a way as to mirror the spatial layout of the gongs rather than their pitch relationships; lines bottom to top are representative of the gongs from left to right. The two groups of 4 and 6 lines were conceived to loosely follow the delineation between left and right hands, mirroring the way two staves are used in some marimba repertoire to represent material separated between the hands. Throughout the work, felt mallets, drum sticks, knitting needles and finger tips are used across the range of gongs, indicated through altered note heads such as cross or diamond shapes (shown below in Figure 2). The spatial displacement of note heads on each line is used to indicate different striking areas, and standard CPN articulations and

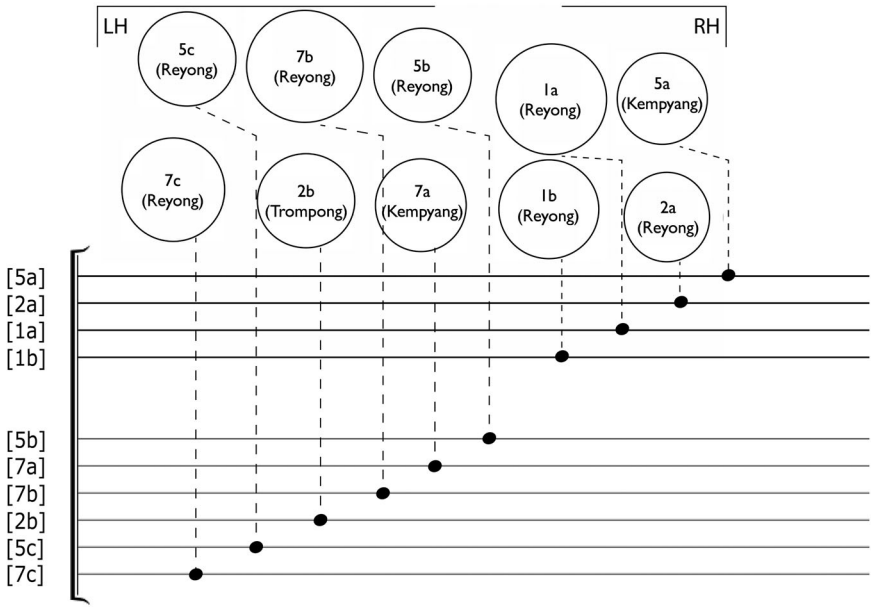

Figure 1 Tablature-style gong mapping for Stuart James' *Kinabuhi | Kamatayon* (2015) movements 1, 2 and 3. © Stuart James. Reproduced by permission of the author.

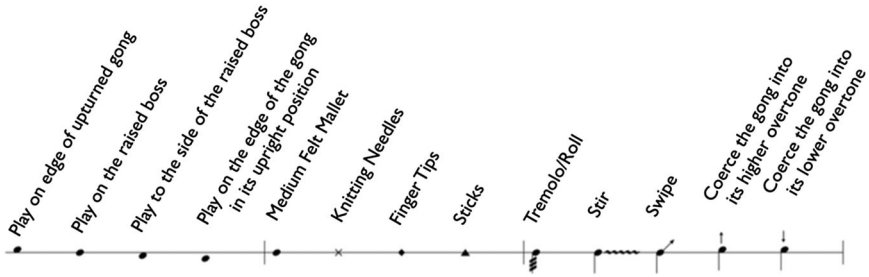

Figure 2 Notational Convention Key for Stuart James' *Kinabuhi | Kamatayon* (2015). © Stuart James. Reproduced by permission of the author.

arrows indicate both gestural (stirs, scrapes) and sonic specifications (coerce the gong to resonate at its highest overtone).

Pitch, rhythm, and dynamics are notated in the score with a high degree of specificity. Although the work is microtonal, gong pitches are specified through a system of tablature, as opposed to the standard pitch staff notation used in CPN. By combining tablature and CPN, both pitch and rhythm are indicated with specificity. It is worth stating that the notation is limited to a small finite set of timbral indications and attack qualities, and is not specific about timbral variance or texture. Therefore, the variance in approach to timbral quality is open to subjective interpretation by the performer, impacting somewhat on the live electronic processing. However, it is fair to suggest that the notated score would assume a high degree of repeatability from performance to performance.

3. Screen-Based Notation

The paper-based technology of CPN has remained almost unchanged for 400 years. Comparatively rapid technological advances, perhaps chief among them colour printing and multimedia-based screen presentation have provided an opportunity for the expansion of the possibilities of the musical score through more comprehensive and integrated data representation. For Hope and Vickery, presenting notation on screen is a solution to specific compositional problems: for example, continuous parametrical changes, synchronisation with the pre-recorded audio or live processing, nonlinear formal organisation, et cetera. The works discussed in this paper exemplify some of the solutions to these issues. One important factor contributing to the efficacy of notation is *semantic soundness*—the degree to which the graphical representation makes intuitive sense to the reader—rather than necessitating learning and memorisation of new symbols.

Hope and Vickery have pioneered the use of colour in their notation. In their percussion works, colour is used in the service of *perceptual discriminability*, one of Moody's key principles for designing cognitively effective visual notations (Moody, 2009). Colour schemes are used in these works to maximise the distinctness of separate

musical media, techniques, and phenomena, such as sound sources, gestural information and timbre. Similar requirements to identify discrete data sets have been studied for the creation of data visualisation (Tufte, 1990), transport maps (Green-Armytage, 2010) and websites (Stanicek, 2009).

The use of graphical shapes to denote sonic morphology is also a key concept in these works, following the hypothesis that graphical symbols can elicit meaning through inherent semantic qualities. This thinking derives in part from neuroscientific research suggesting that 'there may be natural constraints on the ways in which sounds are mapped on to objects' (Ramachandran & Hubbard, 2001, p. 19), and from the field of spectromorphology in acousmatic music, which explores the visualisation of sonic phenomena, as proposed by Giannakis (2006), Thoreson (2010), Blackburn (2011), Pasoulas (2011), and Tanzi (2011). Both Hope and Vickery employ these techniques in conjunction with the extension or replacement of CPN conventions with tablature/gesture, graphical and/or spectrographic notational vocabularies.

4. Tablature Gestural Approaches

Tablature notation physically specifies the spatial positions at which sonic events are to be enacted by the performer. Its use by the Western Avant-Garde can be traced to scores such as John Cage's *Variations III* (1962). Gestural notation, in contrast, specifies the physical motions necessary to enact sonic events. The two approaches have much common ground and are often used concurrently: for example, in Mauricio Kagel's *Pas de Cinq* (1965). Kojs has coined the broader term 'action-based music' (Kojs, 2011) to refer to music that 'emphasises the artistic exploration of mechanical actions which are used to control all aspects of composition, including its conception, form, instrumentation and instrumental design, performance and score' (Kojs, 2009). Such works often provide minute definitions for non-standard 'actions'.

Tablature/gestural notation is particularly pertinent to percussion scores, as it is arguably more capable than CPN of representing spatial relationships convincingly —which is often more complex than those for other instruments—especially in terms of location, position, and means of strike. Figure 3 shows two of the first examples of gestural notation from works by Hope and Vickery. In the Hope

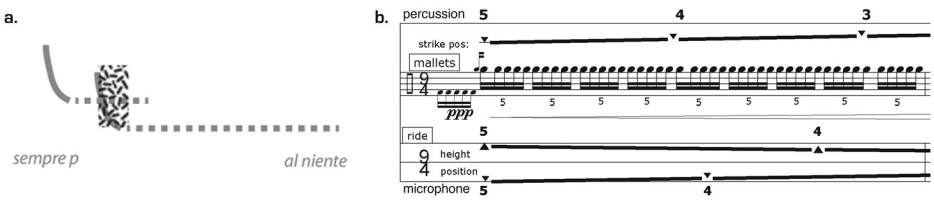

Figure 3 Gestural or Action-based notation in (a) Cat Hope's *Miss Fortune X* (2012) (left), and (b) strike and microphone position indications in Lindsay Vickery's InterXection (2002). © Cat Hope and Lindsay Vickery. Reproduced by permission of the authors.

example (on the left), an instrumental sextet composed for Decibel titled *Miss Fortune X* (2012), the percussion part depicts gestures necessary to perform on two cymbals using double bass bows. These are defined by curved and dotted lines that symbolise the gesture of actuating the sound of the cymbal with a down bow, and then maintain a constant sound with regular up and down bows. The graphic on the second line specifies the second cymbal is a sizzle cymbal. In the Vickery example from *InterXection* (2002) (on the right), the striking position on the percussion instrument and microphone position in relation to the instrument are indicated by lines and numbers.

In three works composed from 2014 to 2015, Hope moved to a graphical notation which primarily specifies percussive gesture through shape and colour. Composed for Louise Devenish, the score for *Tone Being* (2016), for tam tam and subwoofer, consists of eleven 'slides', each with graphic symbols of different shape, thickness and colour, placed within a circle that represents the surface of the tam tam, as shown below in Figure 4. The shape and size of the symbols were selected based on experimentation with the various implements and gestures that the tam tam would respond to effectively, commencing with techniques employed by Devenish in recent interpretations of the seminal compositions *Mikrophonie I* (1964) by Karlheinz Stockhausen and *Okanagon* (1968) by Giacinto Scelsi. The colour of the graphic symbols indicates the mallet type (superball, yarn, hard, brush, and indeterminate) to be dragged over the surface of the tam tam, following the prescribed shape and in the direction indicated by the triangular arrowhead. The shapes may be drawn simultaneously or sequentially, but must be completed within the duration that is dynamically indicated by a graphical onscreen timer. Filled circles indicate single attacks, with colour and size again indicating mallet and dynamics, respectively. In the premiere performance, some shapes were drawn multiple times per slide at varying speeds; others only once. The presentation order and duration of the slides are fixed, and there is a crossfade of four seconds

Figure 4 Eight of eleven slides from Cat Hope's *Tone Being* (2016). © Cat Hope. Reproduced by permission of the author.

between each slide. The instructions call for the performer to 'move smoothly between the slides as they fade over each other', promoting the sense of a ritualistic linear progression, as established by the subwoofer part.

Tone Being was preceded by *Sub Aerial* (2015), composed for The Sound Collectors percussion duo. *Sub Aerial* employs a similar semantic language to *Tone Being*; however, here the instrumentation is only defined partially, and spatial positioning of the instruments is indeterminate. The defined instruments include sheet metal, sandpaper, paper, bass drum, sand, ride cymbal and two a.m. radios for each performer. Performers may also provide other instruments of their choice. Similarly, the 'mallets' include fingernails, hands, or finger; charcoal; butt end of drum stick; large mallet; small branch with leaves; superball on a stick; and the performers' own additions. There are a total of 34 slides used with 10 identical graphics, which are coloured blue, red, blue and red, and two in either blue or red. Colour is employed in *Sub Aerial* purely as a means of differentiating which gestures are to be enacted by each performer. The full complement of graphic morphologies is shown in Figure 5. The performers trace the shapes on and across the instruments; however, unlike in *Tone Being*, the precise physical space in which the shape is drawn is not specified. This result in a far greater interpretive scope than *Tone Being*, as both the gesture size and location, and the instrument(s) that are brought into contact with the gesture, are not defined. For this reason, the instructions have a spatial aspect, in particular, during the two times that each performer must depict the gestural shape of the notation in the air while holding a sounding a.m. radio.

A further difference from *Tone Being* is in the presentation of the slides, which are presented randomly for varying periods, also at random, between 20 and 40 seconds to the performers, the duration again being indicated by a graphical onscreen timer. The line thickness and dynamic equivalence found in *Tone Being* is replaced here by a textual indication of five dynamics that are presented indeterminately with each slide.

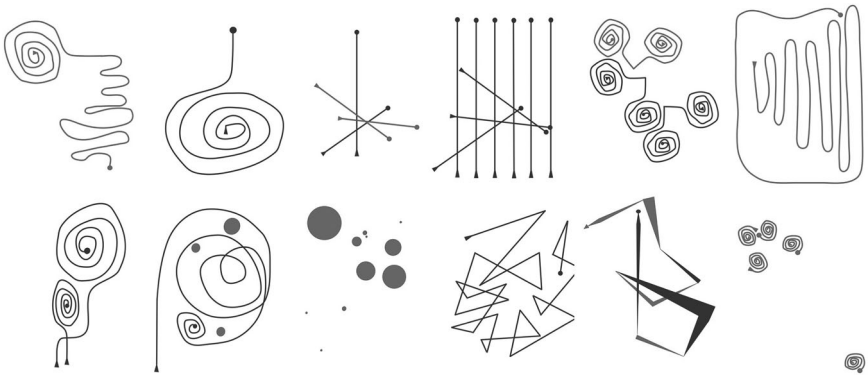

Figure 5 Twelve of the 34 slides from Cat Hope's *Sub Aerial* (2015). © Cat Hope. Reproduced by permission of the author.

Figure 6 shows a post-performance photograph of sandpaper that was used as a sound source in the premiere of *Sub Aerial* by The Sound Collectors. The image illustrates the effectiveness of the spatio-gestural notational approach employed by Hope, documenting the close relationship between image and gesture in the work.

The final work by Hope considered here is *Broken Approach* (2014) for the bass drum kit, a.m. radios, and wind-up mechanisms, composed for Vanessa Tomlinson. Figures 7 and 8 show the score's spatial representation of the physical layout of the instruments. In performance, the iPad screen is viewed in portrait orientation like a traditional player piano roll, so that the right/left orientation of the score mirrors that of the instruments. Like the two works described previously, the score depicts a series of spatial shapes that the performer draws over individual instrument surfaces or the entire drum kit. Unlike the previous works, the score scrolls upwards continuously with the shapes enacted at a precise point: an orange line near the top of the screen. In this sense, the two-dimensional shapes specified in *Tone Being* and *Sub Aerial* are unfolded into a single horizontal dimension, in the manner that a circle is unfolded into a sine wave when drawn onto a scrolling surface. The setup includes two types of wind-up devices—large alarm clocks and wind-up toys—that unwind their coils analogously over time, creating a sustained sonic texture.

The score consists of two gestural identities: points (representing striking an instrument) and lines (representing the continuous dragging of an implement on an instrument). Again the size or thickness of the points and lines indicate dynamics above a median dynamic. The use of a bow, mallets, brushes and two small battery operated

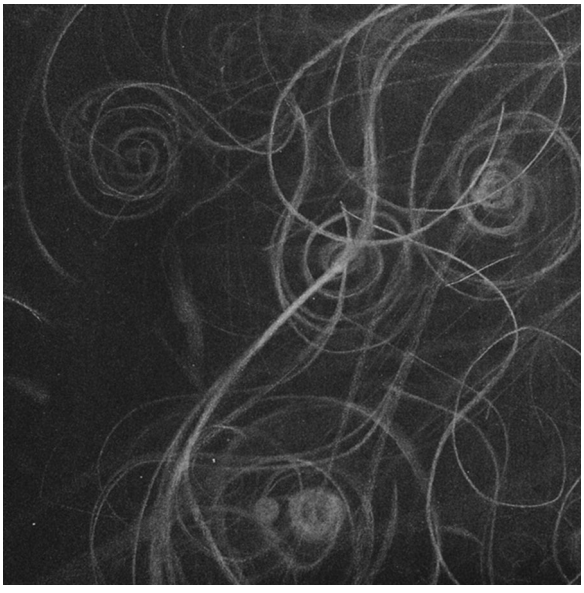

Figure 6 A photograph of sandpaper used as a sound source for The Sound Collectors' premiere performance of Cat Hope's *Sub Aerial*.

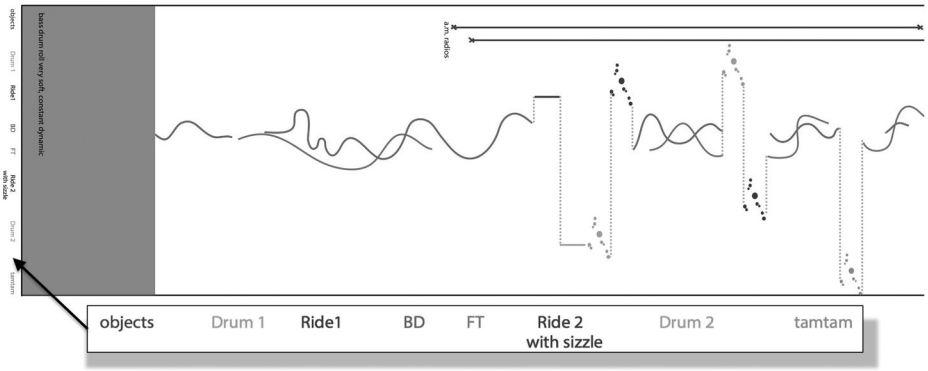

Figure 7 Section one of Cat Hope's *Broken Approach* (2014). The instrument legend on the left of the score is enlarged to make the text legible. © Cat Hope. Reproduced by permission of the author.

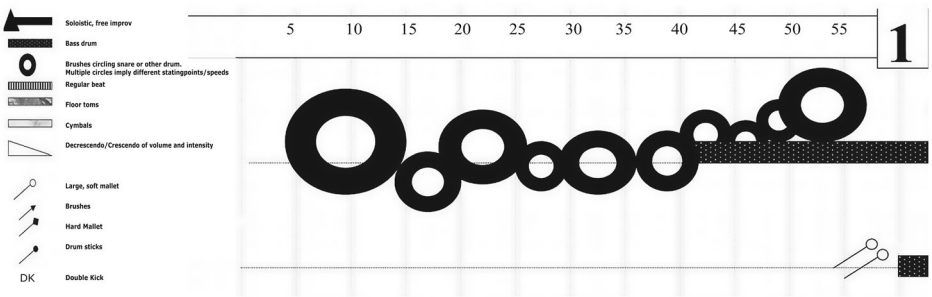

Figure 8 Cat Hope's *Wolf At Harp* (2009) notation key (left) and excerpt 0'-60'. © Cat Hope. Reproduced by permission of the author.

vibrators is indicated by textual instructions. Sections in which the vibrators and wind-up instruments are left on the instrument surface to vibrate by themselves are indicated by extended dotted lines.

The four works discussed here provide evidence of Hope's evolving approach to screen-based percussion notation, developed with percussionists around Australia. Although some commonalities exist, such as the use of lines to depict gesture, no attempt to create a generalizable notational language has been made. Each score uses notation to serve particular timbral, dynamic, and gestural requirements, developed in workshops with the commissioning performers. Hope describes the first of the three works, *Broken Approach*, as exploring 'an emphasis on the line as annotation for timbre, time and harmonic development' (Hope, 2016). This exploration is continued in *Sub Aerial* and reaches its most effective use in *Tone Being*. An advantage of this spatio-gestural notational approach is that it gives the performer(s) an intuitive space to explore timbral possibilities of the instruments. Rather than attempting to

ensure the consistent repeatability of each work, this notation embraces the uniqueness of individual performers, their instruments and instrument collections. Although difficult to measure, Hope's percussion notation clearly has an aesthetic impact beyond the specification of gesture. The characteristic visual style imparts a focus on timbre and line that is arguably distinct from traditional notation. Here, 'the score becomes the location of the identity of the work, of the practice inscribed in it, of a certain aesthetic, of a particular graphology, an individual marking, a vision of the world' rather than a fixed document (Francois, 1992).

5. Spectrographic Notation

A further approach to notation is the direct visual depiction of sonic phenomena to be emulated by the performer. The spectrogram, displaying the energy of each frequency band over time, is perhaps the most accurate method for the precise visual representation of sound. However, there are number of impediments to using the spectrogram as a notational language. The depiction of sonic phenomena in a spectrogram does not take into account the psychoacoustic parsing of the 'auditory scene' (Bregman, 1990) by the human auditory system, in which sounds are both fused and segmented according to their perceptual attributes (Adkins, 2008; Grill & Flexer, 2012). A number of the limitations of representing sound and notation is discussed in detail in Vickery (2014).

Despite these potential shortcomings, spectrographic representation of sound as a form of notation has advantages, and particularly for the depiction of continuous sonic phenomena such as dynamic and timbral evolution. In *The Miracle of the Rose* (2015), composed for The Sound Collectors, Vickery blends CPN conventions with gestural and spectrographic notation. Figure 9(a) shows how spectrographic notation is used in this work to specify the amplitude of the sound visually by vertical height, and the timbral richness of the bowed cymbal notation by hue, while the onset the event is marked by a CPN-style stem and the bow direction by an angled CPN-style beam. Thin curved lines are used to indicate the performer's movement toward and away from the cymbal. In Figure 9(b), the notation continues the established convention for beam direction. A curved line indicates the pitch and the direction (red

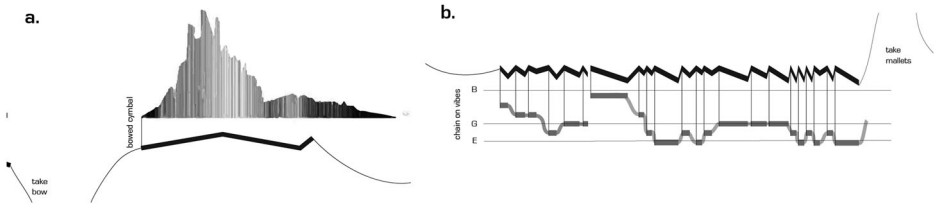

Figure 9 Blending of CPN conventions with gestural and spectrographic notation in Lindsay Vickery's *The Miracle of the Rose* (2015) (a) bowed cymbal, and (b) metal chain lowered and raised onto vibraphone keys. © Lindsay Vickery. Reproduced by permission of the author.

representing lowering and yellow representing raising) for the performer to apply light metal chain onto vibraphone keys.

The bowed cymbal notation shown in Figure 9(a) was originally created using generative spectral notation devised by Vickery for another percussion work entitled *Lyrebird Environment Player* (2014). The notation indicates the amplitude of the sound by the vertical height, the timbral richness by hue. Onset of the gesture is indicated by the note stem position, and bowing direction by the upward or downward inclination of the beam.

The scrolling score of *The Miracle of the Rose* is projected behind the percussionists in performance, allowing the audience to see the coordination between the performers' ritualistic gestures and the score. The work is based on a passage concerning the time altering nature of solitary confinement from Jean Genet's novel *The Miracle of the Rose* (1946). A collage of time stretched recordings of the text spoken by Australian-French artist Emmanuelle Zagoria was used as an underlying structure. The spoken phrases were transcribed for the two percussionists into gestures, exploring their cadence and timbre through varied instruments and notational approaches. Figure 10 shows the correspondence between the spectrographic and notated representations of the collage recording in the score.

Vickery takes the exploration of spectrogram notation further in the percussion solo *Lyrebird* (2014). Composed for Vanessa Tomlinson, the work takes the form of a software-based application that visualises the sonic features of any continuous unedited field recording, and thus allows interaction between live performer(s) and natural sounds. The performer is provided with a real-time scrolling spectrographic visualisation of an environmental recording 12 seconds in advance of it sounding so that the recording is heard synchronously with its visualised auditory features as they reach

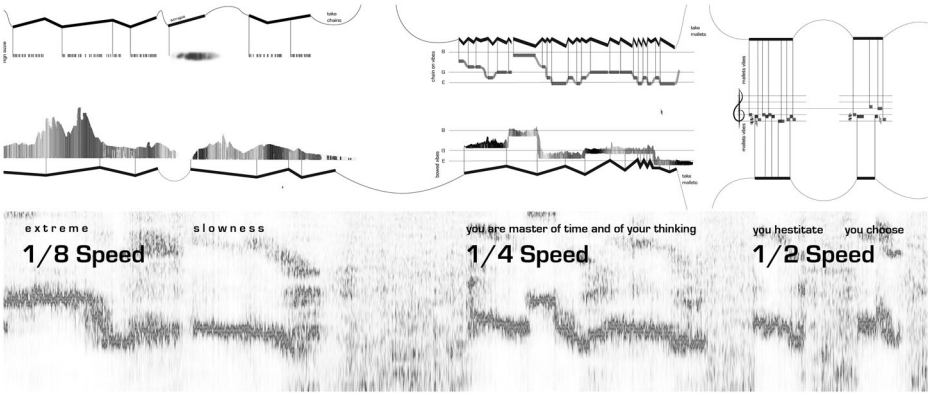

Figure 10 Corresponding visual depictions of the collage audio in the score (top) and spectrogram (bottom) in Lindsay Vickery's *The Miracle of the Rose* (2015) (excerpt). The depicted text is shown at the top of the spectrogram. © Lindsay Vickery. Reproduced by permission of the author.

the left side of the screen. This arrangement creates the continuous proportional notation-like spatial representation of events in the recording, allowing the performer to anticipate their interaction using appropriate extended techniques and/or improvisation to recreate sounds that fall within the context of the field recording. The performer is encouraged to engage with natural sonic environments in a site-specific manner, using field recordings and sonorous objects from the vicinity of a performance.

A delay of 12 seconds, resulting in a scroll-rate of approximately 1.3 cm per second, was chosen as a trade-off between the degree of detail in the visualisation and legibility for the performer. A slower scroll-rate effectively 'zooms out' the visualisation, resulting in a lower resolution of sonic detail. However, the scrolling information on the screen becomes increasingly hard to read as reaches the 'fixation threshold of the human eye' (Picking, 1997). Sight reading studies by Gilman and Underwood (2003) imply a maximal threshold rate for scrolling of about 3 cm per second. Crucially, this rate allows the performer to apprehend morphological detail of 'human-scale' auditory phenomena; that is, within the limits of the mental chronometry of the human auditory system and human motor response time.

The representation of a recording in *Lyrebird* is a compromise between a traditional musical score and a spectrogram. The issues of poor 'coindexation and segmentation' in spectrographic representations, discussed by Adkins (2008), are addressed in the software by generating an alternate form of the spectrogram. Rectangles are continuously drawn according to the pitch of the strongest sinusoidal peak (represented vertically) and the amplitude (represented by rectangle size). They are coloured according to a simultaneous analysis of timbral features (brightness, noisiness, and bark scale) which are mapped to hue, saturation, and luminance values of the rectangles. This process aims to assist the visual identification of auditory features through the correspondence of hue with timbre, as well as general morphological characteristics (Figure 11).

6. Interpreting Notation

As mentioned in the introduction, contemporary percussion is diverse by definition, existing in a state of constant evolution. This makes the creation of new notation a

Figure 11 Lindsay Vickery's *Lyrebird Environment Player (Kookaburras at Sunrise)* (2014) (excerpt). Field recording by Philip Kenworthy. © Lindsay Vickery. Reproduced by permission of the author.

necessary part of the process of developing a new repertoire. This has impacted on the percussionist's performance practice, and rather than becoming fluent in a standardised form of percussion notation, percussionists have instead developed fluency in interpreting a range of notational forms. As a result of this practical experience with various forms of notation, percussionists are able to offer essential feedback in the development of notation for new works. The following paragraphs discuss interpreting the notation used in these case studies from the perspective of the performer. Here, two key areas of interest emerged: readability of the score from the performer's perspective, and repeatability of the work.

Each work was developed in close collaboration with the performers who commissioned the work, including feedback on the notation design and accompanying instructions for each score. All multi-percussion works, including those using CPN or a derivative, require explanation, usually in the form of detailed notation keys, interpretation instructions, and/or photographs. For each of the works, the score is accompanied by a number of instructions or suggestions with regard to instrumentation, striking implements, and interpretation with varying degrees of specificity. In some cases, such as *Kinabuhi | Kamatayon*, the striking implements listed in the score instructions are based on those selected by the original performer during the initial workshop stages. In others, such as *Tone Being*, only some of the striking implements are specified to encourage future performers to expand on these suggestions.

A number of these works have been performed by different percussionists, resulting in vastly different interpretations. Interpretation of each work begins with instrument choices, which in turn influences practical considerations. In some works, only a brief list of suggestions is included, granting each performer artistic license that will result in the work existing in multiple forms. While the instrumentation of *The Miracle of the Rose, Broken Approach*, and *Tone Being* is fixed, *Lyrebird* and *Sub Aerial* are examples of works of fixed notation with wide-ranging realisations stemming from the generative nature of the scores and consequent instrumentation choices. This, in turn, engenders specific performance practices appropriate to the instrumentation selected. An example can be found in Table 2 below, which outlines the instrumentation selected in two different interpretations of *Lyrebird*.

Another key issue is readability for the performer. The lack of standardised notation for percussion frequently results in composers approaching the development of notation for a new work from a structural perspective; that is, a designing notation that will clearly highlight structural hierarchies in the work. This is particularly prevalent for works that are using fixed, unconventional instrumentation. Consideration of readability is crucial, and this can have a significant impact on the notation design. Hope's *Broken Approach* offers an example. Figure 10 showed the order of instruments as they appear on the scrolling score from left to right. Bass drum, toms, and cymbals are common in a percussion setup, and are frequently notated with the relative pitch of the instruments in mind; for example, the highest cymbal pitches might appear at the top, or to the far right or left). Here, the notation layout reflects the spatial setup

Table 2 Variable instrumentation choices in Vickery's *Lyrebird*.

Vanessa Tomlinson (2014)	**Hamish Upton (2015)**	**Hamish Upton (2016)**
Upturned metal mixing bowl	Aluminium foil	Kalimba
Upturned metal saucepan	Bubble wrap	Tubular bells
Upturned temple bowl	Plastic shopping bag	Suspended cymbal
2× metal cowbells (large and medium)	Disposable plastic sushi tray	Tom-toms
Aluminium tube	Small bowl with marbles	
Thunder drum	Handheld a.m./f.m. radio	
Ceramic flowerpot filled with woodchips		
Small temple bowl filled with small stones		
Metal chain		
2× garden stones		

favoured by Tomlinson in 2014. In order to avoid conflicts between the notated and physical layout of the instrumentation, and for ease of reading, subsequent performers are advised to match this spatial layout.

In the development of *Kinabuhi | Kamatayon*, discussions surrounding the readability and practicality of various forms of notation for various sections were continuous. Early drafts were notated to clarify and separate different functional layers of musical material in order to demystify the structural impetus of the work. This notation was

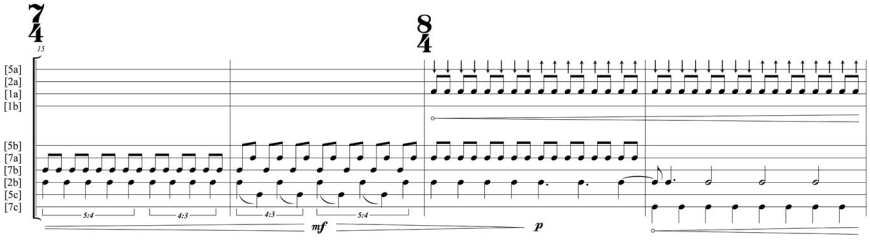

Figure 12 An excerpt from Stuart James' *Kinabuhi | Kamatayon* (2015), bars 15–18 from Movement 2. © Stuart James. Reproduced by permission of the author.

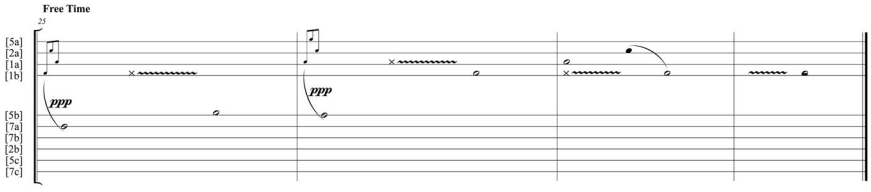

Figure 13 An excerpt from Stuart James' *Kinabuhi | Kamatayon* (2015), in which the score functions more as an aide-memoire. © Stuart James. Reproduced by permission of the author.

Table 3 Media, score, presentation and audio characteristics of percussion works composed by Cat Hope, Stuart James, and Lindsay Vickery between 2014 and 2015.

Composer	Work	Medium	Presentation	Notation	Audio
Cat Hope	*Broken Approach*	iPad/Decibel Scoreplayer	Linear scrolling	Gestural	NA
Cat Hope	*Sub Aerial*	iPad/Decibel Scoreplayer	Non-linear flash-card	Gestural	NA
Cat Hope	*Tone Being*	iPad/Decibel Scoreplayer	Linear flash-card	Gestural	Fixed audio file
Stuart James	*Kinabuhi | Kamatayon*	Paper/Max	Linear segmented	CPN	Real-time processing/ samples/click-track
Lindsay Vickery	*Lyrebird*	Laptop/Max	Generative scrolling	Spectrographic	Variable audio file
Lindsay Vickery	*The Miracle of the Rose*	iPad/Decibel Scoreplayer	Linear scrolling	Hybrid CPN/ spectrographic/ gestural	Fixed audio file

ideal at the composition stage, highlighting the relationships between pitches and musical structure. James' desire to cluster gongs of similar pitch in specific areas of the setup for amplification and processing purposes created a setup that was not in ascending or descending pitch order. As with *Broken Approach*, navigation of the final setup by the performer informed the development of notation, enabling logical sticking patterns. The final score functioned primarily as a traditional score of fixed notation depicting rhythms and pitches (Figure 12), and occasionally as an *aide memoire* (Figure 13), depicting attacks of indeterminate duration where the gesture is left to the performer (Figures 12 and 13).

7. Conclusion

The accurate and effective notation of percussion music is a wicked problem, permanently beset with the demands of varying instrumentation, as well as compositional and technological requirements. While it is clear that these demands frequently require unique solutions, the works discussed in this paper provide solutions and approaches that are valuable in the context of a range of current compositional concerns.

James' notation observes more traditional concerns, communicating composed rhythmic and metric relationships, and underlying structural relationships, within the framework of CPN. The use of colour and graphical shape to represent parameters such as timbre, sonic morphology, and gesture in the works of Hope and Vickery reflects an embrace of advances in printing and presentation technologies. The techniques developed in these works to represent non-metric, indeterminate, tablature/ gesture and timbre-based music could be applied to other notational problems

including multi-parametric specification and representation of electronic and non-anthropogenic sound.

The openness of notational approaches developed in Hope and Vickery's works is a response to the emergence of a more co-compositional or improvisational strain of musical composition, in which the performer's role is amplified beyond direct interpretation. These developments encourage a wider definition of the identity of a work that may encompass significant variation in the realisation from one performance to another. In the case of *Sub Aerial*, this variation includes the permutation of musical materials and instruments, and in the case of *Lyrebird*, the wholesale replacement of the core sonic materials for each performance.

The use of a scrolling score in a number of these works is a logical development from Earle Brown's concept of proportion. The visual synchronisation of the score and sound sources is a useful tool for the coordination of performers with pre-recorded sound and live sound processing. Together, the related but distinct methods employed by these three composers contribute a valuable piece of the puzzle in the representation of performative parameters for percussionists (Table 3).

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No potential conflict of interest was reported by the authors.

Notes on Contributors

Lindsay Vickery's music includes works for acoustic and electronic instruments in interactive-electronic, improvised or fully notated settings, ranging from solo pieces to opera and has been commissioned by numerous groups for concert, dance and theatre. He was a founding member of Alea New Music Ensemble (1987–1992), Magnetic Pig (1992–2003), HEDKIKR (2002–), Decibel (2009–) and GreyWing (2016–) and has toured as a soloist and with ensembles in festivals through Australia, Asia, Europe and the United States. He is active as a lecturer, writer and critic and is a regular contributor to international journals and conferences. His research interests are in fields of Screenscores, Eye-movement tracking, Interactive Music and Non-Linear Formal Structures. He is currently coordinator of the Composition and Music Technology Program at the Western Australian Academy of Performing Arts, Edith Cowan University.

Louise Devenish is a Perth-based percussionist whose practice incorporates performance, directing, research and education. Her work with contemporary, world and interdisciplinary ensembles includes co-directing percussion duo The Sound Collectors, directing Piñata Percussion, percussing for electro-acoustic sextet Decibel and curating the annual Day of Percussion, a full-day event exploring percussion via performances and workshops. Louise works regularly with Speak Percussion (Vic) as a percussionist and contributor to Sounds Unheard. An advocate of Australian music, Louise has commissioned over 40 percussion works and has recently completed a Doctor of Musical Arts

researching the development of Australian contemporary percussion music, which culminated in the show Australian Music for One Percussionist. In 2012, she studied at the University of California San Diego with Steven Schick. Louise is Head of Percussion at the University of Western Australia School of Music, where she also teaches world music and musicology, and lecturer for the acting and music departments at WA Academy of Performing Arts. Her research is published in Musicology Australia, Resonate, Percussive Notes and PERCUSscene.

Stuart James is a composer, sound artist, percussionist and academic based in Perth, Western Australia. His works have been performed nationally and internationally and he has been commissioned by the Australian Broadcasting Corporation, Decibel New Music Ensemble, Tetrafide Ensemble, the WASO New Music Ensemble, percussionist Louise Devenish, and visual artist Erin Coates. Stuart's current work reflects a diversity of composition practice ranging from acoustic and electroacoustic concert music, acousmatic music, spatial music, electronic music and production, AV and multimedia installation, interactive systems, and computer programming. Stuart teaches in the Composition and Music Technology stream of the West Australian Academy of Performing Arts, and has been diversifying his own research in the areas of music analysis, sound synthesis, interactive systems, sound spatialisation, psychoacoustics and perception theory, music notation and digital score delivery, and historiographical research.

Cat Hope is an academic with an active profile as a composer, sound artist and musician. She is the director of the award-winning new music ensemble Decibel and has toured internationally. Her composition and performance practices explore the physicality of sound in different media, and has been discussed in books such as Loading the Silence (Kouvaris, 2013), Women of Note (Appleby, 2012), Sounding Postmodernism (Bennett, 2011) as well as periodicals such as The Wire (UK, 2013), Limelight (Aus, 2012) and Neu Zeitschrift Fur Musik Shaft (Ger, 2012). Her compositions have been recorded for Australian, German and Austrian national radio, and her work has been awarded a range of prizes including the APRA|AMC Award for Excellence in Experimental Music in 2011, 2014 and the Peggy Glanville Hicks residency in 2014. She is a Churchill and Civitella Ranieri Fellow, and has been resident at the Visby International Composers Centre in Sweden. She has collaborated with Australian visual artists such as Tracey Moffat, Kate McMillan, Erin Coates, and Tina Havelock-Stevens and has written work for the London Improvisers Orchestra amongst others. Cat Hope is the co-author of 'Digital Arts – an Introduction to New Media' on Bloomsbury Academic and was the lead CI on the ARC-funded 'Western Australian New Music Archive' with the State Library of Western Australia, Tura new music and ABC Classic FM. Her research encompasses digital archiving, graphic and digital notation, low-frequency sound, and Australian music. She is a member of the Australian Research Council's 'College of Experts'. In 2017, she was appointed Head of the Sir Zelman Cowan School of Music at Monash University.

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