Screening the Score

Lindsay Vickery

Beginning in the 1950s, a range of new paradigms emerged for the presentation of musical notation to live performers. A concerted effort was made by some composers to liberate the score from the manacles of left-right/up-down orientation. These investigations with traditional paper scores, included Earle Brown's *December 1952*, a graphical score capable of performance in any orientation[1]; Morton Feldman's *Intermission 6* (1953), a score permitting the performer(s) "mobile" choice in ordering of the musical materials[2] and Iannis Xenakis' *Duel* (1959) for two orchestras, that delegated the ordering of musical materials to the conductors and calculated their strategic success according to game theory[3].

Such experiments might be said to exemplify remnants of old artistic media "pushing against their own boundaries"[4] *(Žižek 2000 p. 39)* in an attempt to achieve novel conceptual outcomes. Significant obstacles to the development of "real mobility" in notated music remained insoluble in the paper medium. The space-inefficient nature of the paper-score imposed an inverse relationship between the ease of mobility and the amount of information that could be provided for performer(s). Coordination of multiple performers in mobile works required either the predetermination of a pathway through the work's materials or unwieldy mechanical methods, such as the visual cues from coloured lights found in Xenakis' *Duel*. Arguably the developments in the "mobility" of the paper score, "seem to point towards a new technology that will be able to serve as a more "natural" and appropriate "objective correlative"[5].

The computer, as a result of improvements in graphics, processing capacity, smaller, lighter and cheaper screens and data projection available since the 1990s, was the technology that provided a more natural medium and allowed a new-found actual mobility for the musical notation. The computer afforded a practical, pragmatic medium for presenting information to the performer, and the possibility of coordinated algorithmic and interactive control of multiple performers and multiple media.

> One general effect of the digital revolution is that avant-garde aesthetic strategies became embedded in the commands and interface metaphors of computer software. In short, the avant-garde became materialized in a computer[6].

Tools for coordination of performers included the use of networking of multiple computers, screens and clicktracks, and digital generation of sound and processing of live acoustic sounds. These approaches promoted the emergence of a range of practices that might collectively be referred to as the "screen-score".

Digitisation of the score allowed liberations from the "fixed score and (…) progress to a concept of polyversional works".[7] In addition to presentation of the score on the computer screen, digitisation also made it possible to project the score, giving "the audience insight into a work's formal structure and evolution, but also invest(ing)

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1. Brown, E. (1986). The Notation and Performance of New Music. The Musical Quarterly, 72(2), 180-201. p. 193
2. Hirata, C. C. (1996). The Sounds of the Sounds Themselves: Analyzing the Early Music of Morton Feldman. Perspectives of New Music, 34 (1), 6-27. p. 9
3. Griffiths, P. (1975). Logic and Disorder. The Musical Times, 116(1586), 329-331 p. 330
4. Žižek, S. (2000). The Art of the Ridiculous Sublime. Seattle, Washington:: University of Washington Press.p. 9
5. Ibid.
6. Manovich, L. (2001). The Language of New Media. Cambridge, Mass.: MIT Press. p. 258
7. Winkler, G., (2010) 'The Real-Time-Score: Nucleus and Fluid Opus', Contemporary Music Review, 29: 1, p. 90

those scores with additional aesthetic and musical significance.[8] Arguably, making projection of the score gave rise to a new kind of artwork, in which the graphical aesthetics of the score contribute to the totality of the experience for the audience.

1. Classifying the Screen Score

Clay and Freeman note that terms to describe the range of new approaches have not yet been standardized[9]. There are four principal considerations governing the relationship between these new screen-based approaches and the traditional notated score.

MEDIUM	COMPOSITION	PERFORMER	SCORE
Screen-score	Generative	Immanent/ Interactive	real-time score
	Transformative		
	Permutative		
	Sequential	Interpretative	scrolling score
Paper-score	Permutative	Explorative	Mobile score
	Sequential	Interpretative	traditional score

Table 1. Paradigms for the presentation of notation to live performers [10]

1. Medium - the expanded range of approaches may give rise to either static or dynamic arrangement of materials analogous to traditional print text and computer-based hypertext.

2. Composition - the musical materials may be configured so that they are read sequentially, permutated, transformed or generated in real-time. The computer-generated score provides a seamless medium for such approaches.

3. Performer - the relationship between the performer and the score may be characterized as interpretative (of a traditional score), explorative (of a "mobile score"), 'Immanent' in that reading may be expected to occur more "in the moment" or interactive in the case that the performer's actions result in changes in the score.

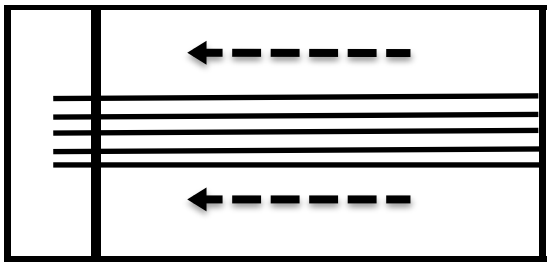
4. Score - Traditional musical notation implies the abstraction of taking a continuous 'scroll' of music and splitting it into sections that can be arranged on successive pages. The scrolling score uses the computer to actualize the continuous paradigm of linear music on screen. In the mobile paper score, the notation remains fixed on paper, but *"the order of musical sections is outlined either just before or during performance"*[11]. The real-time score *"refers to any notation, either traditional or graphic, which is created or transformed during an actual musical performance"*[12].

1.1. The Scrolling Score

The scrolling score moves a continuous notational graphic from left to right, allowing performers to execute events as they strike a fixed "playhead". This approach is best suited to scores that are notated proportionally, that is the time durations of the

1. ———————————

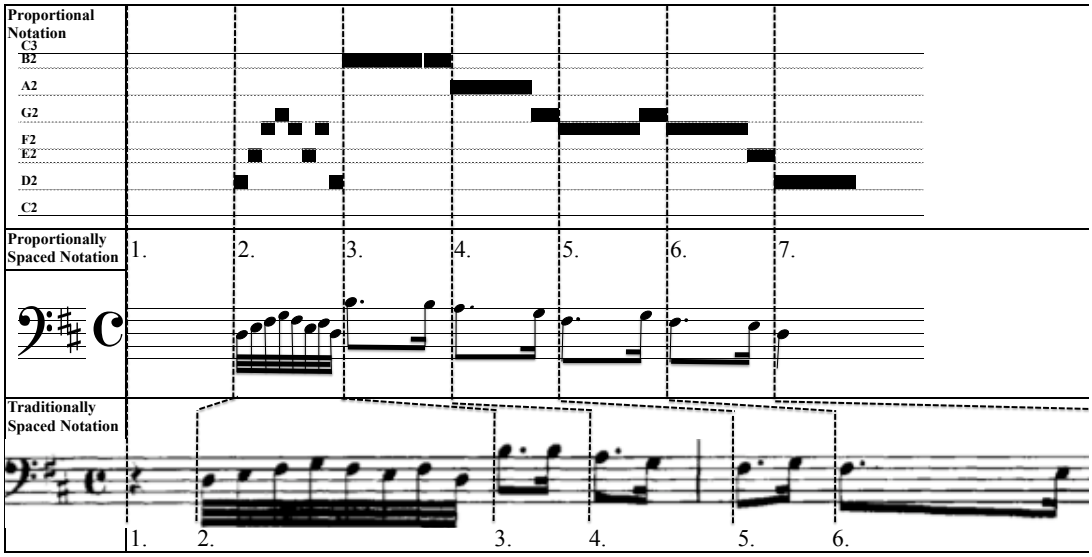
8. Kim-Boyle, D., (2010). Real-time Score Generation for Extensible Open Forms, Contemporary Music Review, 29: 1, p. 5
9. Clay, A., & Freeman, J. (2010). Preface: Virtual Scores and Real-Time Playing. Contemporary Music Review, 29 (1), p.1
10. The categorizations in this table are based on similar categories proposed by Aarseth in his work *Cybertext: Perspectives on Ergodic Literature* (1997).
11. Kim-Boyle p. 4.
12. Clay and Freeman p. 1



Example 1. Scrolling Score and fixed playhead

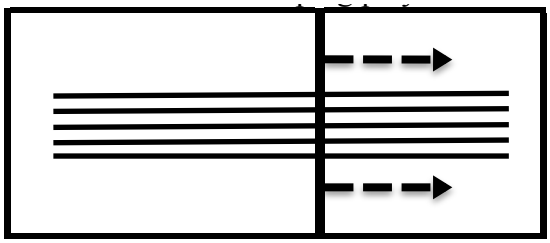
musical events are proportional to the spacial lengths of their graphical representations.

Note lengths are principally determined by their shape, in traditional notation. To save space, traditional scores do not typically place musical events proportionally on the page: longer notes tend to take less space in comparison to short notes and spacing may be dependant upon the duration of events that are taking place across multiple staves. (See Example 2 below.)



Example 2. The opening of Bach's D major Fugue BWV 850 in traditional notation (below), proportional traditional notation (centre) and graphically ("piano roll notation") (above).

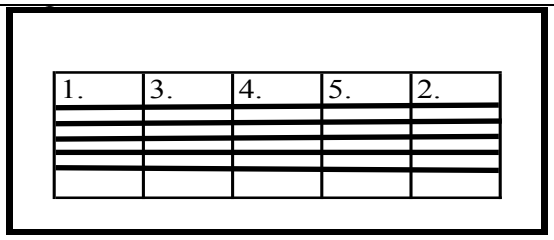
For this reason the scrolling score is best suited to proportional graphical notation. It allows graphical scores that would normally need to be broken up over multiple pages, such as Penderecki's *Threnody to the Victims of Hiroshima* (1960), to be presented to performers as an unbroken continuum, revealing to the performer only what they realize in each moment and what will be subsequently realized.



Example 3. Fixed Score with swiping playhead.

It is also possible to swipe the playhead across the score. Such an arrangement limits the amount of graphical material that is visible to a single page or "screen". It is therefore not suited to the presentation of continuous "multiple page" scores, however this limitation provides the opportunity for nonlinear presentation of the material, in the manner of a permutative score.

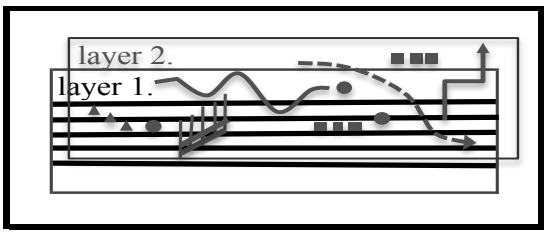
1.2. The Permutative Score



Example 4. The Permutative Score

The permutative score allows the presentation of materials to the performer in an indeterminate order. It is capable of being continually "refreshed" with additional materials. Musical events of short duration or longer passages may be presented in this manner. This approach is suitable for traditional or graphical notation. The ordering of the events may be determined algorithmically, by the computer or interactively through an interface, such as hardware or computer listening. In Jason Freeman's *Glimmer* (2004) for chamber orchestra and audience participation, for example, the audience influences the unfolding composition "by waving four-inch battery-operated LED light sticks back and forth" in front of video cameras[13].

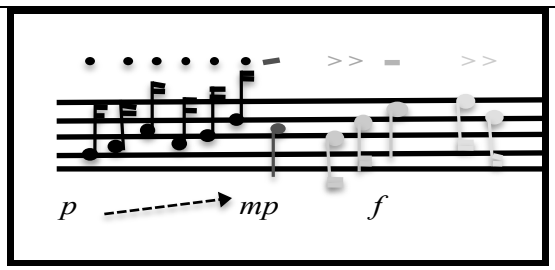
1.3. The Transformative Score



Example 5. The Transformative Score

The transformative score allows a fixed score to be altered in real-time. It is the digital descendant of Stockhausen's *Refrain* (1959), a work in which the score is overlayed by a mobile clear plastic strip that modifies whatever the material is below it and John Cage's *Cartridge Music*, which invites performers to assemble a combination of sheets and transparencies to create each part."[14]. In addition, the computer provides a medium in which the score itself can be graphically modified on the screen in a mobile manner.

1.4. The Generative Score



Example 6. The Generative Score - Traditional Notation

The generative score constructs components of the score in real-time. The components may comprise traditional or graphical notation or a combination of both. Algorithmic or interactive methods of generation may be employed, with the score moving from left to right or cyclically like a closed loop of paper. In David Kim-Boyle's *music for 2*, for example, "the pitch grid displayed for the performers is dependent upon the dynamic level with which preceding grids are performed"[15].

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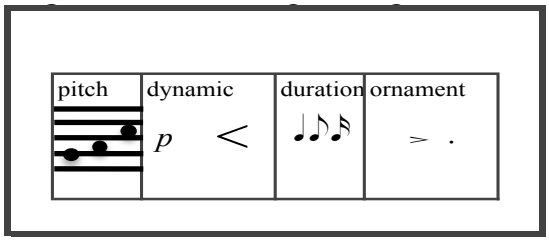
13. Freeman, J. (2008). Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance, Computer Music Journal, Volume 32, Number 3, Fall 2008, p. 35
14. Rebelo, P. (2010). Notating the Unpredictable, Contemporary Music Review, 29: 1, p. 23
15. Kim-Boyle p. 9

Additionally, elements of the score may be presented to the performer independently.



Example 7. The Generative Score - Separated parameters

This approach is used in the extended notation of the highly complex paper scores of Aaron Cassidy, that often notate different components of instrumental technique on up to ten independent, simultaneous staves[16]. Application of these ideas using digital media allows for these processes to take place in real-time. This approach is exploited in Gerhard Winkler's *Hybrid* series (1991-)[17], which permit

> unique navigational pathways through the work to be explored, and opens exciting formal and notational possibilities which clearly cannot be achieved with paper-based notational systems."[18]

2. The Screen Score in practice

The following examples of works developed for the new music ensemble Decibel.

2.1. Cat Hope's Scrolling Screen-score *In the Cut* (2009)

Beginning with *Kingdom Come* in 2009, Cat Hope has created a body of works that employ a single horizontal span of graphical notation to be read and performed as a continuous score. The first work of Hope's that was performed by Decibel was her second continuous score *In the Cut*. The work features long descending glissandi terminating in the unspecified lowest possible detuned pitch for five instruments: violin, cello, bass clarinet, bass guitar and turntable. The work is pulseless, but requires temporal and sometime pitch synchronisation between the players.

Each of *In the Cut*'s five instruments is represented in the score by a different colour. Unlike some graphic scores, *In the Cut* presents the performers with a relatively unambiguous representation of the sounds they are to enact: a horizontal line is a continuous pitch, when it stops, the player stops, when it angles downward, the player descends in pitch. This simplicity and lack of complex rhythmic codes mean the score is easy to follow and understand for any viewer. Conversely the realised sound of the work is inherently complex, with interactions between the incrementally changing frequencies of the parts creating dynamic complexes of sound including beating patterns, interactions with the acoustical space and other phenomena (see Figure 8).

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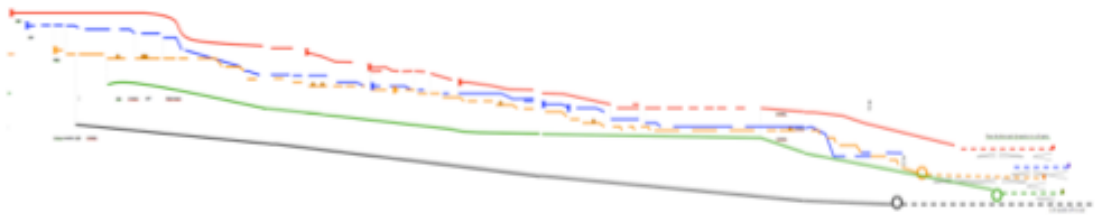
16. See Cassidy's notes to his solo saxophone work *asphyxia*: http://www.aaroncassidy.com/music/asphyxia.htm
17. Winkler, G., (2010) The Real-Time-Score: Nucleus and Fluid Opus, Contemporary Music Review, 29: 1, pp. 89 — 100
18. Kim-Boyle p.12

a.



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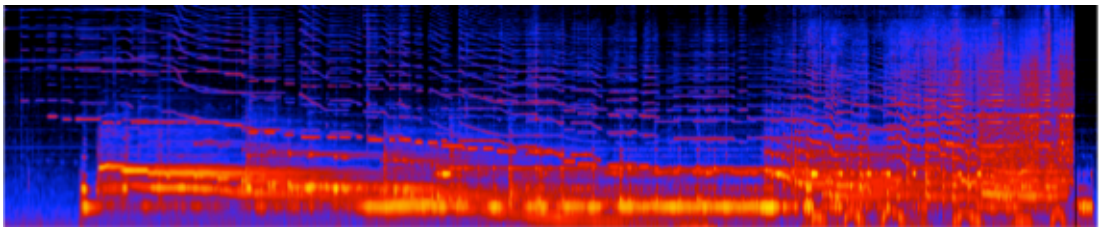

Figure 8: Cat Hope *In the Cut* (2009). a. The full score b. A spectrogram of a performance of the work.

The original score of *In the Cut* was printed on five A3 pages. It was clear in early rehearsals that traditional performance practice was not the best fit for the work: events could only be accurately synchronised if an arbitrary pulse was imposed on the work and conceptually, the sense of a mass of continuous intertwining lines was disturbed by adding a pulse and disrupting the continuous flow of the graphics with page turns. The obvious solution was to read the continuous score from a scrolling "score-reader" – this way the lines remained unbroken, no external pulse needed to be added and synchronisation could occur visually.

A "score-player" was developed in MAX/MSP by Lindsay Vickery that allowed the image to pass by a line of synchronization or "playhead". The playhead provided the point at which the musicians should actualize the graphical notation. In this way, the "score-reader" operates in a paradigm not unlike the play-head on a tape recorder. The scores were projected onto a screen to facilitate synchronised reading by the ensemble.

The scrolling Score-Player provides a medium in which the unique characteristics *In the Cut,* continuous glissandi, can be realised without the necessity of imposing an arbitrary time grid onto the work. For the performers, this approach gives a clear representation of the essential conceptual quality of the work: an unrelenting descent to unknown depths.

2.2. Lindsay Vickery's Permutative Screen-score *Antibody* (2010)

Antibody, a work for alto flute, clarinet, viola, cello, keyboard and electronics, employs a permutative score to explore a formal structure based on biological principles of mutation. Five musical cells, each nine measures long with a distinct tempo and texture, are subjected to "mutation" through the processes of deletion, duplication, insertion and translocation. Nine measures of the score, read from laptop, are presented to the performers in each cycle. At the end of each cycle there is a break (of increasing length) in which the measures are reassembled, creating increasingly diverse hybrid arrangements each time.

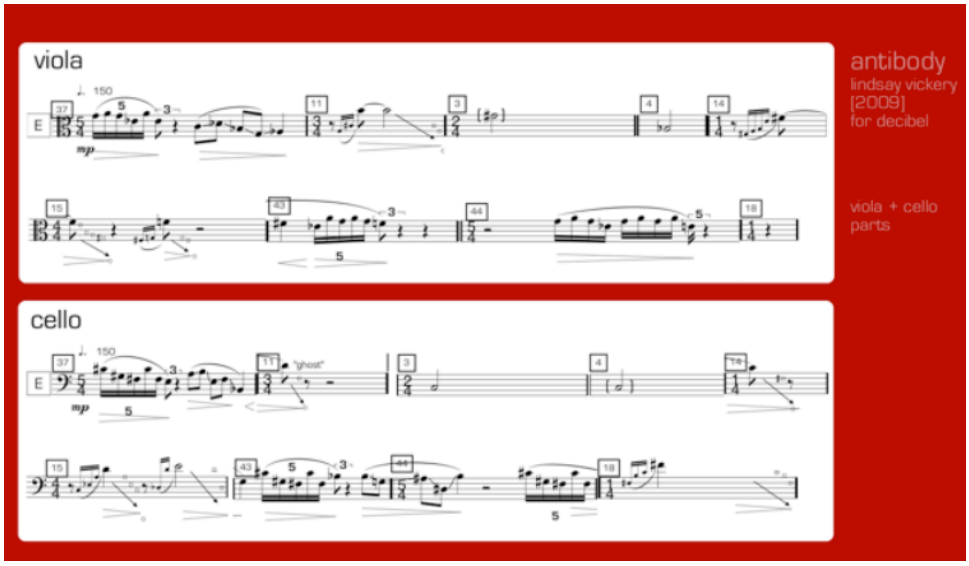

Figure 9. A screenshot of the string parts from *Antibody* (2010), showing measures permutated in the order mm. 37, 11, 3, 4, 14, 15, 43, 33, 18.

In the first section of the work the five cells are played in an order chosen algorithmically by the computer, but with each nine-measure span remaining unmodified. In the second section the five cells are performed again, but this time with some measures from the previous cell inserted. In the subsequent sections the inserted measures are drawn from the two, three and finally four previous cells. By the final section the five cells have completely interpenetrated one another. (See Figure 10).

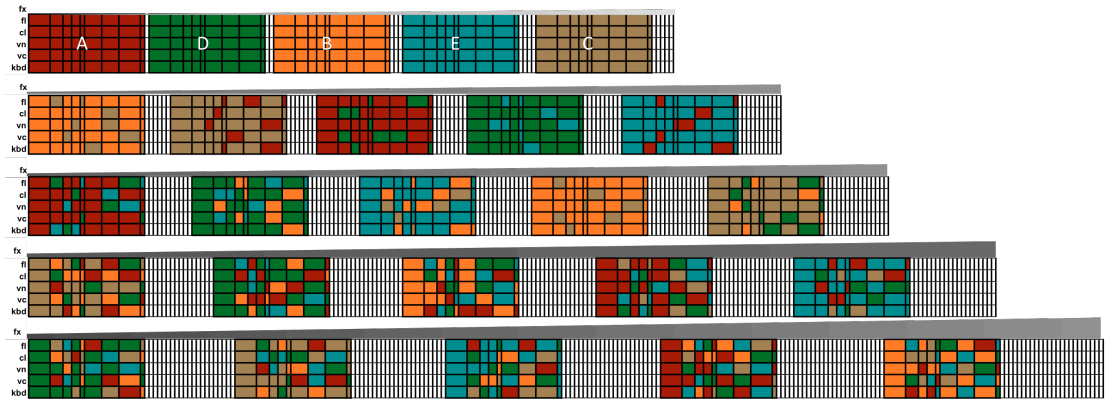

Figure 10. A representation of a notation formal structure created by a performance of *Antibody,* showing the progressive degree of permutation of materials and the increasing periods of improvisation between the notated passages and electronic processing of the acoustic sounds.

The contrasting but related tempi of the five cells (mm. 30, 60, 90, 120 and 150), mean that measures are performed at a new tempo when they are inserted into a different cell. As a consequence they are continuously transformed each time they are played. Between each cell is an open period, from four to twenty seconds, during which the performers are instructed to reflect upon these transformations through improvisation based on material they have just played.

Digital processing of the acoustic instruments provides a final level of transformation. Each player is separately recorded and processed and the degree and rate of processing is increased throughout the duration of the work.
The performers are synchronised in tempo by clicktracks sent via headphones. Three computers, displaying the scores for alto flute and clarinet, viola and cello and keyboard, are networked together to provide synchrony between the evolving scores.
Antibody achieves the kind of sectional mobility found in Block Form works such as Stravinsky's *Symphonies of Wind Instruments* (1920) and sub-motivic mutation pioneered by Debussy in *Jeux* (1912). However, through the use of the Screen-score, these processes result in reordering of the work in each performance.

2.3. Lindsay Vickery's Transformative Screen-score – *Transit of Venus* (2009)

Transit of Venus is a work for three performers with multiple independent click tracks and a projected graphical score. In addition to following the tempo of their individual click track, each player must also follow a transformative Screen-score comprising a set of symbols that dictate the direction of their dynamics, changes in the texture that they play, the pitch class resources that they should use to realize the score, and finally the period of time over which these changes should occur (Figure 11.).

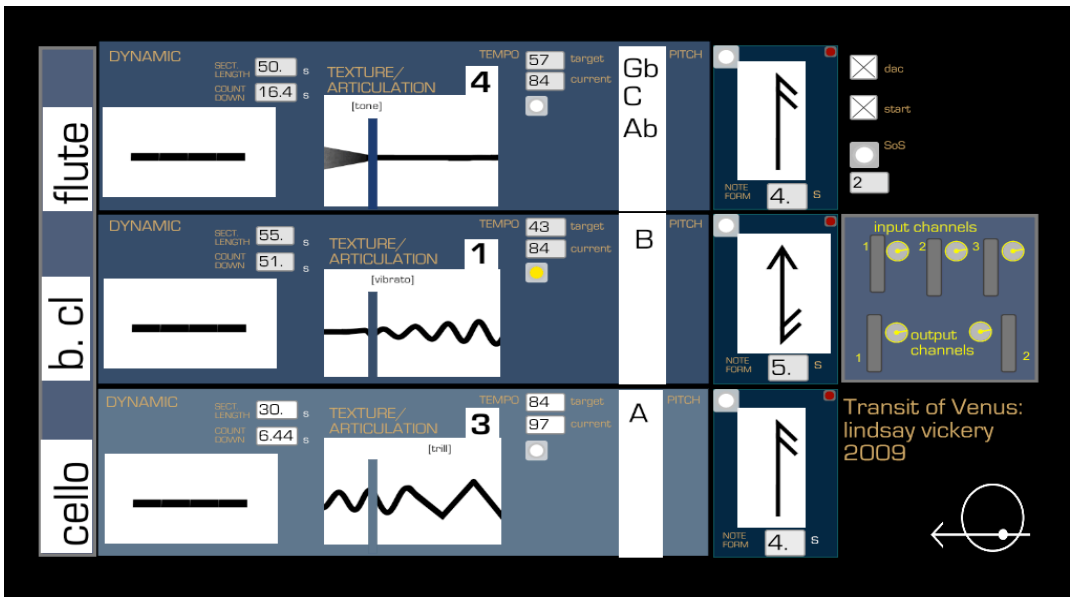

Figure 11: Lindsay Vickery: Transit of Venus (2009) Screen-score

The graphical arrangement of the score-player for *Transit of Venus* atomises and separates the functions of the traditional score, where performance indications are vertically unified. This configuration allows independence to be established between parameters such as texture, pitch, dynamics and articulation. Each parameter is controlled in an asynchronous and nonlinear manner, creating the potential for a very large number of possible realizations of the work. In this way, the work's configuration of information is only made possible by the computer medium.

The work alternates between two principal modes. The first presents a scrolling continuum of musical textures (Figure 12.). For example, if the performer is playing a single tone and receives the indication add vibrato, they should transition from the first texture to the second continuously over the indicated time-period.

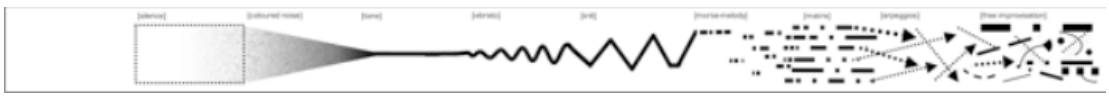

Figure 12: The scrolling continuum of musical textures from *Transit of Venus*

The second is a free section during which the continuum and the metronomic click are suspended for all three performers. During these periods each performer follows the note-form indications (Figure 13) that appear for short periods on the right of the screen.

Figure 13. Note-form indications from *Transit of Venus*

Figure 14a. is a notional representation of the structure of a performance of *Transit of Venus*, showing the order of texture continuum material presented to players and interruptions by free sections throughout the work. *Transit of Venus* is a nonlinear work, in that the tempo, and scroll-rate of the continuums is variable in each performance and each performer moves in and out of synchrony in relation to the other two. Figures 14b. and 14c. are spectrograms of different performances demonstrating a range of realizations of the work.

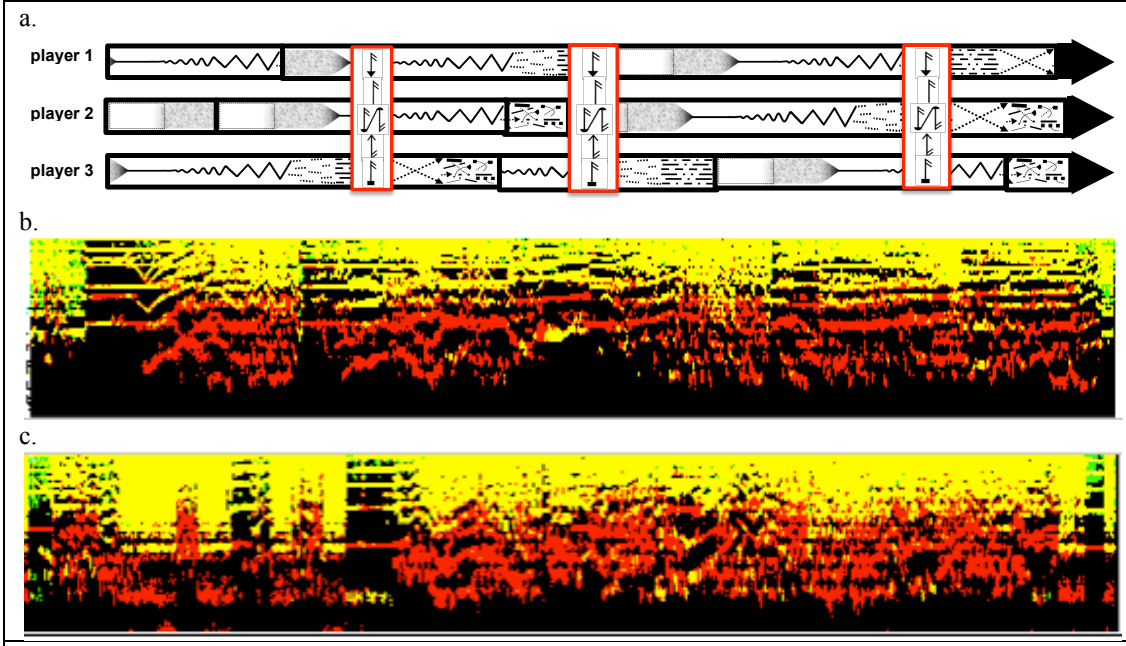

Figure 14a: Transit of Venus a. Notional representation of the formal structure 14b. String Trio Performance 14c. Decibel Performance

2.4. Generative Screen-score - *Possible Stories of Harry Power* (2010)

Possible Stories of Harry Power explores the idea of fabrication of mythologies around the life of the Australian folk hero, the bushranger Ned Kelly. Three instruments representing the Harry Power, Kelly and Kelly's mother, read their pitch and volume from a projected graphical score. Each instrumental line is depicted in a different colour in what are essentially four a maps both of the pitch, duration and timbre of each line and the versions of the recorded movements of Power, Kelly and his mother in relation to each other in time.

In this work, there are a number of versions: composer versions, computer versions, player versions and combinations of all three. In performance, the first "map" (Figure 15.) is played and simultaneously rendered by the computer into a second map incorporating the computer's errors, this second map is then played and the process is repeated, recasting the score into a third map incorporating yet another layer of "Chinese whispers" style elaboration. The final section returns again to the composer's rendering of yet another version of the intertwining trajectories of the three characters (Figure 16.).

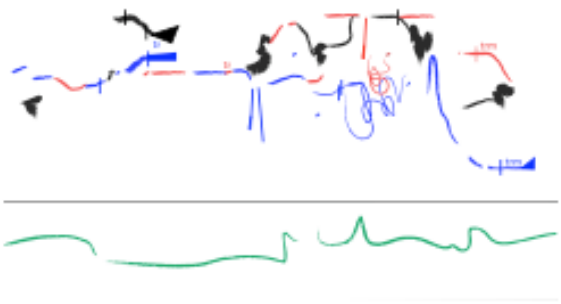

Figure 15: Section 1 of *Possible Stories of Harry Power*: the initial graphical notation score presented to the musicians.

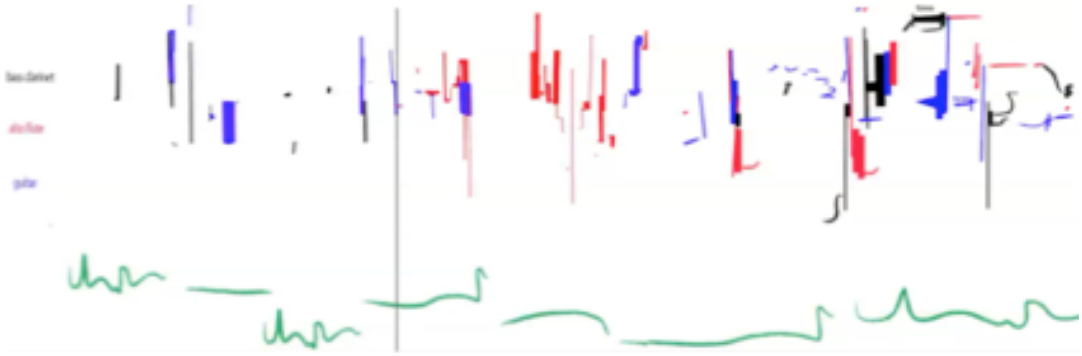

Figure 14: The final 3 sections of *Possible Stories of Harry Power, showing the computer renderings of the performer's realization of section 1 and 2 and the final graphically notated section.*

The computer patch, created in Max/MSP by Kynan Tan, "listens" and "retells" the performer's reading in an analogy to oral transmission. The three performers are recorded via contact microphones, the computer analyses the instruments' pitch, inverts them and then renders them proportionally in three contrasting colours as the next portion of the score. As such, *Harry Power,* casts the computer's generative potential in a narrative role, taking advantage of the inaccuracies in the computer's transcription, to enact an analogy to the transformation of oral transmission of narrative.

3. Conclusion

For centuries the relationship between the composer, the score and the performer have remained remarkably constant. The advent of random access computing has created a range of new opportunities for revolutionising the interaction between the parties involved in musical performance.

The screen-score liberates and sets in play essential qualities of the score, "that it is a system of symbols which can convey, guide, or control the interactions between

elements such as space, time, rhythm, people and their activities and the combinations which result from them".[19]

Centralisation of coordinational functions in the computer allows diverse elements of contemporary composition such as mobile score components, sound-file playback and synchronization and electronic sound processing. Synchronisation of performers through visual, on-screen timers or metronomes and aural, distributed clicktracks greatly enhance the range of possibilities available to the composer. Finally, the screen-score repositions the role of the score as a mediator between notation and improvisation and performer/machine interaction.[20]

Cornelius Cardew claimed that "notation and composition determine each other".[21] Digitising and screening compositional scores, provides a more "natural" medium for new formal paradigms in musical composition such as the scrolling score, permutative score, the transformational score and the generative score. These new freedoms raise novel issues for the composer: "how many and which details to control, which aspects to 'set free', which things to 'allow' to happen, and where to draw the borders of the musical world?"[22] The four discussed works from Decibel's repertoire, exemplify some of the potential solutions to these issues opened up by the possibilities inherent in the screened score.

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19. Hanoch-Roe, G. (2003). Musical Space and Architectural Time. International Review of Aesthetics and Sociology of Music, 34(2), p. 146

20. Ibid.

21. Cardew, C. (1961). Notation—Interpretation, etc…. Tempo (New Series) 58(3), p. 21

22. Winkler p. 90