Mobile Scores and Click-Tracks: Teaching Old Dogs

Lindsay Vickery
Western Australian Academy of Performing Arts, Edith Cowan University

ABSTRACT

This paper reconsiders the paper score as a medium for presentation of mobile score works. The precedents leading to the development of mobile form in music are discussed. The form and modes of realisation of a range of works by Earle Brown, Karlheinz Stockhausen, Iannis Xenakis, John Zorn, Mauricio Kagel, Charles Ives and Denis Smalley are examined. The potential for computers to provide a more 'natural' medium for mobile scores is explored.

A number of computer-based solutions to the realisation of mobile scores are proposed in regard to: the single page mobile score, the multi-page mobile score, the mobile graphical score, the polytempo score and works that include pre-recorded sound and/or live electronics. Solutions including the on-screen scrolling score, the on-screen timer, the computer controlled click-track and networked multiple computers are proposed. The potential to control musical parameters such as formal structure, tempo, meter and dynamics are explored, as well as the ability to represent "free" pitch and rhythm.

1. INTRODUCTION

In the 1950s a concerted effort was made in some quarters to liberate the music score from the manacles of left-right/up-down orientation. The idea evolved, both in music and across a range of art forms in the mid-twentieth century, all sharing a common impetus to generate the opportunity for multiple readings defined by the individual.

Zizek claims that, as developments in ideology and formal innovation are interlocked, ideology and technology also evolve in parallel. He argues that

> *old artistic forms pushing against their own boundaries and using procedures which, at least from our retrospective view, seem to point towards a new technology* [1].

The mid-century saw a sudden abundance of ideas pushing against their own boundaries and pointing exploring towards a new paradigm of openness and mobility in art works. The following table charts these developments across the arts and technology.

1919	*The Magnetic Fields* by Andre Breton and Philippe Soupault explores "automatism" in poetry, seeking *'to express the actual functioning of thought'* [2].
1931	Alexander Calder creates his first sculptural "mobile" *Feathers* [3].
1945	Vannevar Bush proposes the *Memex*: a method of organizing data "as we may think" [4].
1952	Earle Brown composes *December 1952*, a graphical score capable of performance in any orientation [5].
1953	Morton Feldman composes *Intermission 6,* a score allowing the performer(s) to choose the order of the musical events [6].
1959	Iannis Xenakis composes *Duel* for two orchestras introducing the use of game theory to calculate possible musical outcomes [7].
1961	Publication of Raymond Queneau's *Cent mille milliards de poèmes* (Hundred Thousand Billion Poems), a compendium (and "writing machine" for generating) 10^{14} possible "mobile" sonnets [8].
1963	• Theodore Nelson creates the term "hypertext" to describe a system of linking related texts together in the digital medium [9]. • Umberto Eco publishes the first major theoretical text on the field *Opera Aperta* (The Open Work) [10]. • Alain Robbe-Grillet *Pour un Nouveau Roman* (Towards a New Novel), espouses disjunctions in time, place and point of view as a method of breaking down the dominance of the omniscient narrator. [11]. • The nonlinear structure of Federico Fellini's film *8 ½* [12] together with Eco's work inspires the formation and experimentations of Gruppo '63 [13].
1966	Peter Handke creates his first 'speak-in' (Sprechstücke) *Offending the Audience* – a collage of "found" words [14].
1967	Gordon Mumma explores the concept of interactive electronics in Hornpipe, a work capable of 'semi-automatic response to the sounds generated by the performer' [15].
1969	The first Interactive installation *Glowflow* is created by Myron Krueger [16].

Table 1. A timeline of textual mobility in the Arts.

The musical developments towards mobility of the score pioneered by Brown and Feldman quickly spread to the European Avant Garde and elsewhere [17]. However there were significant obstacles to the development of

textual "mobility" in notated music created by its reliance on the printed-paper score. Crucially, the space-inefficient paper-score imposed upon composers an inverse relationship between the ease of mobility and the amount of information that could be provided for performer.

French "Oulipo" [18] author Raymond Queneau created a solution (for poets) in his publication *Cent mille milliards de poèmes* [19] by printing ten sonnets, in which each of the 14 lines is printed on a separate strip of paper. The strips can be arranged in any order, resulting in the potential for producing 10^{14} possible 14-line sonnets. Despite the contention of commentators such as Espen Aarseth that such *'variety and ingenuity of devices'* show *'that paper can hold its own against the computer as a technology'* [20], it is worth noting that, when searching on the internet for Queneau's *Cent Mille Milliards*, 5 of the first 10 results are hypertext realisations of the work[1].

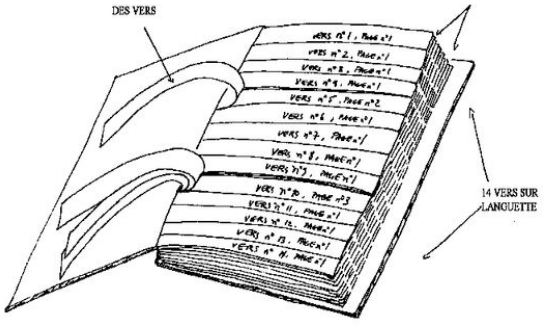

Figure 2: Raymond Queneau's *Cent mille milliards de poèmes*, Image: [21]

Indeed, the computer-based hypertextual medium, while perhaps less idiosyncratic, plainly provides a more, "natural" vehicle for Queneau's project than, again in the words of Zizek, '*the old forms endeavoured to render by means of their "excessive" experiments'* [1].

2. MOBILITY IN THE MUSICAL SCORE: FORMS AND REALISATIONS

In the mobile score, the final ordering and distribution of notated musical events is deferred by the composer until the performance. In such works

> *the instrumentalist's freedom is a function of the "narrative" structure of the piece, which allows him to "mount" the sequence of musical units in the order he chooses.* [22]

Composers have explored this approach for a variety of reasons. According to Earle Brown this strategy provided a greater level of *"spontaneity, direct spontaneous action, and more spontaneity in the compositional process"* [23], allowing *"the performer to share directly with the composer in the construction of the music"* [24]. Stockhausen's earliest mobile structure works, such as *Klavierstück XI* (1956) and *Zyklus* (1959) reflected his interest in representing the aleatoric nature of the structure of sound itself. Later "moment" works such as *Kontakte* (1958-60), *Momente* (1958-60) and *Mixtur* (1964) sought to explicitly avoid traditional musical narrative structure: *"The piece tells no story. Every moment exists for itself"* [25].

Composers such as Xenakis and Zorn have used game structures to draw on mobile form's "field of possibilities" to create tension. In Xenakis' *Duel*, the composer employs game structure to outline 19 tactics of interaction between two orchestras performing notated music. In contrast, Zorn's game pieces are "meta-compositions" that *'deal with form, not with content, with relationships, not with sound ... The improvisers on the stage (are) themselves the sound'* [26]. In both cases, the subject of the work is the inherent drama in the "playing out" of the rules. As the dubious attribution to Sartre says '*everything is complicated by the presence of the opposing team*'.

Another approach, Graphic notation, employed in some of the compositions of Earle Brown, Mauricio Kagel, Roman Haubenstock-Ramati and Sylvano Bussotti, provides a range of possible forms of mobility to the score. Firstly the symbols themselves may be, to greater and lesser degrees, asemic, that is, without semantic content. Their deviation from musical notational conventions points towards meaning that is more "open" to interpretation. Secondly, the avoidance of traditional notational conventions may also imply the freedom for the performer to move around the page in a more interrogative fashion.

> *Composers who work with such notation, where the distinction between symbol and drawing is blurred, hope that it may excite the performer's imagination* [27].

Another form of mobile score comes into being as a result of the compositional technique called polytemporality. First outlined by Henry Cowell in the 1930s [28], polytemporal works feature two or more musical elements moving at different tempi in such a way that they become perceptually distinct. Although some examples of this technique, such as Charles Ives *Symphony No. 4* (1910-16), are notated within a single score [29], they commonly employ multiple conductors or require, as suggested in the score of Xenakis *Persephassa* (1969), coordination via multiple metronomes [30].

Paradoxically, the final example revolves around the tension created by the immobility of the paper score when in combination with pre-recorded sound.

[1] http://x42.com/active/queneau.html, http://www.uni-mannheim.de/users/bibsplit/nink/test/sonnets.html, http://www.bevrowe.info/Poems/QueneauRandom.htm, http://www.smullyan.org/smulloni/queneau/, http://userpage.fu-berlin.de/~cantsin/permutations/queneau/poemes/poemes.cgi

Typically, scored works for "instrument and tape" generate problems for the live performer because of the friction between the intangibility of the pre-recorded sound and the fixity of the notated score. Even when the score is not nonlinear, for example in Bruno Maderna's *Musica su due Dimensioni* (1952) [31], the synchronization of the score and tape components provides a challenge both to the composer and the performer.

The models and examples given cover a range of modes of realization including live performers with and without electronics. In some cases, the implementation of these works in a computer-based hypertextual medium may provide a more "natural" vehicle for their performance by:

- creating a more practical, pragmatic medium for presenting information to the performer;
- preventing performers from preparing a fixed order of the work's materials;
- allowing the choice of nonlinear materials based on aleatoric or other procedures;
- reducing the need for unnecessary cues that create a non-musical distraction to the performers and/or the performance.

3. COMPUTER-BASED SOLUTIONS TO THE REALISATION OF MOBILE SCORES

3.1.The Single page mobile score

Some early mobile scores, such as *Intermission 6* and *Klavierstuck XI,* solved the problem of mobility by employing a single performer and including all of the necessary information on a (sometimes very large) single page. Feldman's work comprises 15 fragments or musical objects, each a single note, chord or grace note. They fit comfortably on a standard sheet of paper and there is no great challenge to the performer in the realization of the work, namely to freely order the fragments.

Although the score for *Intermission 6* is effective and convenient in its presentation of information, a computer-based realization could offer the possibility of avoiding preparation of the event order by the performer, as well as the opportunity to choose the events using a range of aleatoric procedures and predetermine the duration and density of the work.

Stockhausen's *Klavierstück XI* provides somewhat greater challenges for the performer. The work comprises 19 musical passages or "groups", each followed by a three indications detailing the tempo, dynamic and articulation that must be applied the group that is performed next:

> *At the end of the first group, the performer reads the tempo, dynamic and attacks indications that follow, and looks at random to any other group, which he then plays in accordance with the latter indications* [32].

Each group is a complex micro-composition representing *'a sound in which certain partials, components, are behaving statistically…the wave structure of this sound is aleatoric... naturally the individual components of this piece could also be exchanged, permutated, without changing its basic quality'* [33]. The implication of this formal arrangement, where both the order of groups and manner of performing them are variable, is a potentially momentous number of realizations of the score. (Read and Yen have calculated the number as greater than 10^{40} possible permutations [34]). As a result rather than "looking at random" in order to determine the succession of events, many pianists "pre-order" the score into a particular fixed sequence.

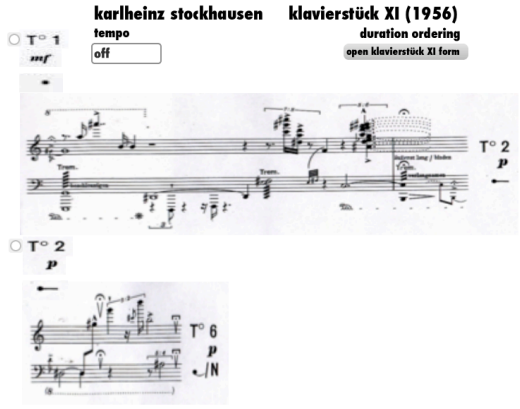

Figure 3: The score-player for Karlheinz Stockhausen *Klavierstuck XI* (1956)

The proposed "score-player" for *Klavierstück XI* provides the performer with the musical group to play as well as the group that will follow it. The performance indications located at the end of each group are repeated above the group they refer to in the position they would normally occupy in a traditional score. The performer may choose to play the work without any precise tempo cues from the computer or receive a click and/or visual flash to negotiate the work's six tempo strata. A "Formal Variables" window allows the performer to control the relative performance duration, inter-group pause duration and whether the choice of groups should favour fast or slow tempi. The window also tracks the order of chosen groups and the duration of the performance for practice purposes.

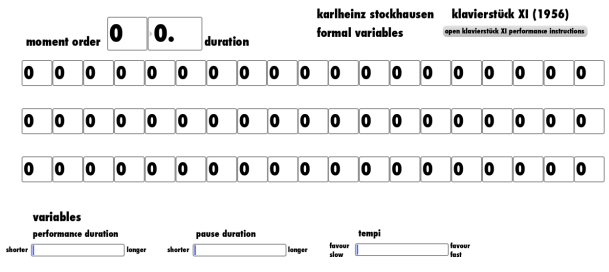

Figure 4: Formal Variables screen for Karlheinz Stockhausen *Klavierstuck XI* (1956)

Stockhausen instructs the performer to 'look at random to any other group' in order to determine which group to perform next. It is hard to imagine how the composer, listener or even performer might verify whether this instruction is being followed. In the case of a paper score however, involuntary choice is the most pragmatic solution for achieving an aleatoric order of groups. Stockhausen's stated motivation for this instruction is '*that the performer will never link up expressly chosen groups or intentionally leave out others. Each group can be joined to any of the other eighteen'* [32]. This suggests that the choice of groups through computer processes would be an equally valid method of achieving an aleatoric order and would not violate the intentions of the composer.

3.2.The multi-page mobile score

The coordination of multiple performers and scores in a live situation creates an even greater impediment to the goal of formal mobility in real-time. Preparation of the order of the events in the score prior to the performance becomes a necessity rather than just a pragmatic convenience. The following account of an early performance of Stockhausen's *Momente* (1962-69) shows the imperative for pre-ordering of the orchestral parts.

> *Stockhausen expects the performer to vary the order of movements at will, and even provides for passages from one movement to be inserted into its neighbors. For each concert the score may be re-arranged, in accordance with certain instructions; the extracts or "inserts" may be glued into certain slits in the score, and their duration and volume are varied depending on the context, as indicated by a long list of rules on each sheet. Then the parts are prepared in whatever order has been selected for the particular concert.* [35]

Clearly the pre-ordering of the performance materials prevents any formal reorganization "at will". Although the ability to assemble a unique sequence of musical events allows a form of "openness" in the score, the pre-ordering essentially reduces the work to a closed form in performance. A computer realization of this work would allow for the 99 pages of *Momente,* including its "inserts", to be ordered in real-time by the computer. The work also uses proportional rhythmic notation dividing the bars into "beat-lines" that may be a constant tempo, if regularly spaced, or a variable tempo if irregularly spaced [36]. A computer could distribute a click track to the performers alleviating the need for a conductor.

Xenakis' *Duel* employs a more radical (and awkward) means of coordination of its two orchestras. Non-notational visual cues, consisting of a complex arrangement of yellow, blue, red and violet coloured lights are used to cue the different musical materials [37]. Such a solution, in addition to being logistically complex, adds a further cognitive layer to the, already taxing, requirements for the performers and arguably creates unnecessary non-musical distraction.

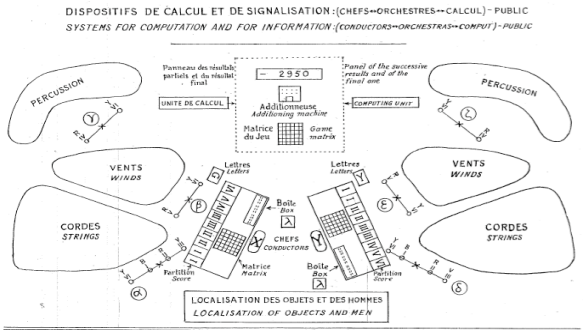

Figure 6: The arrangement of performers and visual cueing systems in Xenakis' *Duel*

Xenakis also details a system whereby '*the conductors of each orchestra duel each other, trying to score the most points over a set number of turns or time*' [38], the choices of the conductors are accorded points and continuously totaled during the performance to decide and ultimate "winner". Xenakis writes:

> *at the end of the combat one might a. proclaim a victor, or b. award a prize, bouquet of flowers, cup, or medal, whatever the concert impresario might care to donate* [39].

Xenakis also suggests that:

> *the successive partial scores can be announced automatically on lighted panels in the hall, the way the score is displayed at football games* [40].

Xenakis's requirements particularly lend themselves to adaption. Indeed, an implementation based on Xenakis' score has been completed by Liuni and Morelli [41], albeit in the form of an installation exchanging the live orchestral performers for pre-recorded sound samples.

The development of John Zorn's game pieces, numbering 27 between 1974 and 1992 [42], is shrouded in mystery due the composer's '*reluctance to publish a complete and detailed account of the work'* [43]. Zorn describes the earliest game compositions as '*creating very simple structures—combinations, for example, of all the possible duets in a twelve-piece group, all the possible trios'* [44].

The most complex (and well known) of the game pieces, *Cobra* (1984), consists of a labyrinth of cues or formal "agents", (Duos, Trades, volume change and so on), communicated by hand signals. Crucially, although there is a centralized "prompter" communicating the formal cues, the musicians themselves propose which cue should occur next. The result of this arrangement is that performances of *Cobra* have a strong theatrical element: '*what you get on the stage, is not just someone reading music but a drama'* [45].

Cobra is arguably an example of a work that would not benefit from translation into a computer-driven

paradigm. What might be viewed as short-comings in Zorn's model, distracting hand-signals for example, are actually integral to the work and contribute not only to the spectacle, but to its essence as a piece of competitive improvisatory theatre.

3.3. The Mobile Graphical Score

Earle Brown is credited with composing the first instance of open form, '*filled with nontraditional notational signs and symbols, ... with the resulting shape totally unfixed and different each time'* [46]. The score for his *December 1952* is "open" in a number of ways:

> *The 'ambiguity' of the notation exists with regard to the macroform (ordering of modules or units); to the microform (how to interpret one graphic symbol in relation to its neighbours); or to the time process (between groups of materials in minute, flexible detail, as in proportional notation).* [47]

The score called for a new kind of paradigm in the performance of New Music: improvisational composition. Brown's original intention was that the performers should be left entirely to their own devices in the realization of the work, however as he later indicated, the creation of a new paradigm combining composition and performance required a level of creativity not always reached in by performers accustomed to traditional notated music.

> *I had this idealistic, romantic feeling that I could* (create improvisational composition)*, with a graphic score and classical musicians … I couldn't understand why classical musicians couldn't improvise, and why so many looked down on improvisation.* [46]

If the problem with scores such as *Klavierstück XI is* that the detailed notation lends itself to pre-ordering by performers into a linear form indistinguishable from a "closed" work, the problem with the very openness of *December 1952* is that it lends itself to improvisation with little regard for the score. The freedom created by allowing the unspecified interpretation of the range, duration and nature of the sound events as well as the orientation of the score and rate at which it should be read, leaves the performer with little necessity for precision in their interpretation.

The proposed score-reader for *December 1952* (and by extension any graphical score), features a left-right scrolling score with "playhead" representing the current moment. This arrangement allows the score to be presented in any orientation, in any magnification and to be scrolled at any rate. An optional "scalable" grid adjacent to the playhead allows the performer to assign pitch to vertical strata of the score.

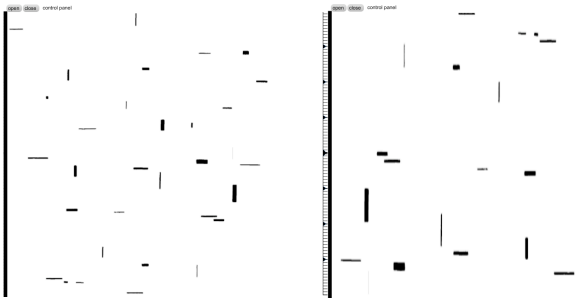

Figure 7: Two screen-shots of the score-player for Earle Brown December 1952. The second screen is the vertically enlarged, inverted, retrograde of the first.

Mauricio Kagel's *Prima Vista* (1962-3) provides for a comparable level of openness to *December 1952*. The work consists of 25 pages containing graphical notation that specifies the dynamic envelope, number and relative duration of sound events. The length of time taken to play each page is not specified.

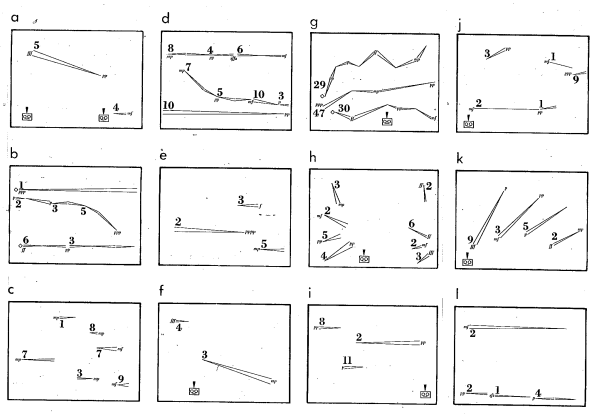

Figure 8: Score components (Letters a. through l.) of Mauricio Kagel: *Prima Vista*

Like *Duel, Prima Vista* is performed by two ensembles, but with each ensemble including a performer replaying pre-recorded samples of the opposing group. The original instructions specify projection of the score using slide projectors, a requirement that must surely have distracted aurally from the performance.

The score-player for *Prima Vista* chooses the 25 slides without repetitions and provides the performers with a countdown indicating a varying duration for each page. The available range of durations of the pages is adjustable, allowing the total length of the work to be controlled.

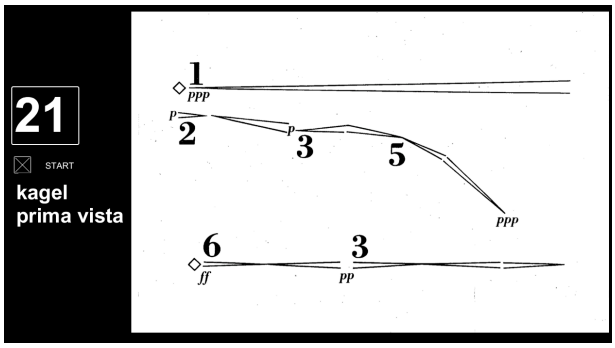

Figure 9: Score-player for Mauricio Kagel: *Prima Vista* (1962-3)

3.4.The Polytempo score

Charles Ives' experiments with polytempo techniques may date back to 1898. Three early works by Ives from the first decade of the 20th century, *Three Harvest Home Chorales* (1898-1912), *Central Park in the Dark (*1906) and *The Unanswered Question* (1908) all feature independent tempi, including accelerandi in different parts of the orchestra [48]. In the notes to *Central Park in the Dark* Ives states '*the relation of the string orchestra's measures to those of the other instruments need not and cannot be written down exactly, as the gradual accelerando of all but the strings cannot be played in precisely the same tempi each time'* [48].

The desire to obtain precise coordination of live performers led to the development of mechanical means for the management of multiple tempi by Emmanuel Ghent [49]. In his 1967 article *Programmed Signals to Performers: A New. Compositional Resource,* Ghent outlines a method by which '*performers could maintain complete independence as to tempo, meter, and positioning of the beat, and yet be precisely coordinated in time*'. The analog system used '*a magnetic tape recording on which signals to the individual performers (had) been pre-recorded at different pitch levels*' [50]. Ghent also identified the potential application of this system 'as a means of synchonising electronic tape music with live performers' and for works exploring '*wide spatial separation*' [51]. A further development of the system by Robert Moog allowed for the '*control of electronic devices such as oscillators, amplifiers, frequency modulators…*'[51].

Ghent observes that '*performers adapt very quickly to the use of the miniature headphone'* [52]. It is possible that once familiar, the regular click replaces the need for an internally generated sense of pulse and may even reduce the cognitive load on the performer.

The computer-generated clicktrack creates the opportunity not only to independently control the tempi of multiple performers, but also to transmit formal (for example nonlinear selection of score materials) and performance (such as articulation, dynamics and so forth) parameters in real-time. Such an arrangement resembles the innovative methodology of Mexican Soap opera producer Televisa, albeit with a different motivation.

> *in 1951 a Mexican engineer invented an electronic earpiece for instant communication with actors that became a standard and somewhat unique element of the Televisa production process. Performers could be fed their lines, either between takes or while taping was in process; as a result, the speed of recording was greatly enhanced* [53].

3.5. Inclusion of pre-recorded sound and/or live electronics

The final category of work places the fixed notated score in opposition to the real-time playback of a sound-file. Leah Barclay conducted a survey of performers in 2009 and concluded that in regard to performing with pre-recorded sound that:

> *the majority of artists … simply require more information and a visual representation of the electronic part* [54].

As Barclay observes the notation of the electronic component of such performances needs to be extremely accurate to match the precision offered by traditional notation and its performance conventions. An additional solution to the issue of coordination is the introduction of an on-screen timer and/or metronome to synchronise the acoustic and electronic components.

The score-player for Denis Smalley's work *Threads* (1985) centralizes the control of playback of the audio component, synchronised with an on-screen timer and mobile realisation of Smalley's score, providing the means of precise synchronization.

It is worth noting that such an arrangement also conveniently "bundles" together all of the materials necessary for a performance of the work. This is true of all of the examples mentioned and can be seen as a potential benefit to the continued longevity of these works.

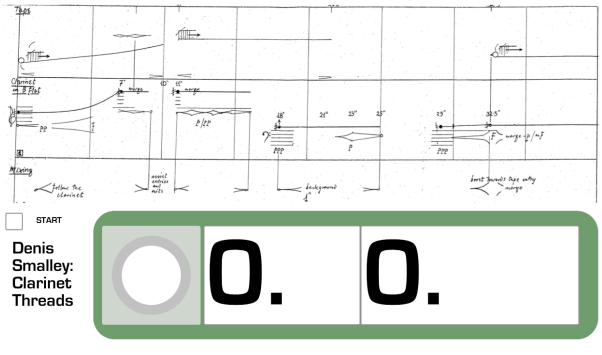

Figure 10: Score-player for Denis Smalley: *Threads* (1985)

Miller Puckette, Marc Battier, Simon Emmerson and others have written on the need to restore electronic works from the past and to preserve them into the future [55, 56, 57]. There is something of an "authentic instruments" debate on the question of the restoration of works from the past. Stockhausen took the conservative view:

> *It's extremely important to comprehend works, which were born to a particular historical moment, for their uniqueness… it is my experience of music that every instrument, every item of equipment, every technique can produce something unique, which can be achieved in no other way. Since that is the case, then we can speak of an original technique, and thus deal with an original instrument* [58].

Simon Emmerson takes a more pragmatic view.

> *But are we aiming at 'authenticity'? Once we embark on such an enterprise, the regress is infinite. Must we demand original instruments and original performance practice on these instruments? The composer's original intentions may not be inscribed in any single document, in any medium. The same arguments apply here as in the endless debates on 'early music interpretation' – except we (may) have the recorded medium to help us.* [59]

It is this author's view that technological "refits" to mobile form works could be considered in the following circumstances:

- the work can still be performed according to the composer's intentions
- the original work would operate more "naturally" within a contemporary medium that was not available at the time of composition.
- the "refit" significantly improves the performing situation, for example: facilitating more accurate performance or improving the logistical requirements for the work.

4. CONCLUSION

The potential solutions to the realisation of paper-based mobile scores proposed above can be summarized as follows:

- A dynamic mobile screen-based nonlinear or scrolling score;
- Use of visual synchronization methods such as on-screen timers or metronomes;
- Use of computer controlled click-tracks to synchronise and transmit formal or other musical parameters;
- The centralization of the score, sound-file playback, synchronization and electronic sound processing.
- The bundling of performance materials, score sound-files, electronics and means of synchronisation into a single unit.

In addition to providing a more "natural" medium for some existing mobile scores, these solutions present a range of opportunities for the exploration of novel performance and formal paradigms.

REFERENCES

[1] Zizek, S., 2000. *The Art of the Ridiculous Sublime.* Seattle Washington, Walter Chapin Centre for the Humanities: Occasional Papers 1, University of Washington Press. p. 39

[2] Breton, A., Seaver, R., & Lane, H. (1969). *Manifestos of Surrealism*. Ann Arbor: Ann Arbor Paperbacks. p. 26

[3] Selz, P. 1966. *Directions in Kinetic Sculpture*, Berkeley: University Art Museum p.72

[4] Bush, V. (1945). As We May Think. *Atlantic Monthly* 176(1), 101-108.

[5] Brown, E. (1986). The Notation and Performance of New Music. *The Musical Quarterly*, 72(2), 180-201. p. 193

[6] 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

[7] Griffiths, P. (1975). Logic and Disorder. *The Musical Times,* 116(1586), 329-331 p. 330

[8] Dack, J. (2005). *The 'open' form – literature and music*. Paper presented at the The Scambi Symposium, Goldsmiths College, London. P. 2

[9] Nelson, T. H. (1967). Getting It Out Of Our System. *Information Retrieval: A Critical* View (pp. 191-210). Washington, D.C.: Thompson

[10] Eco, U. (1989). *The Open Work*. Cambridge, Massachusetts: Harvard University Press.

[11] Robbe-Grillet, A. (1963). *Pour un nouveau roman*. Paris: Minuit.

[12] Fellini, F. (Writer). (1963). *8 ½*. In A. Rizzoli (Producer). Italy: Cineriz.

[13] Kezich, T. (2006). *Federico Fellini: His Life and Work*. New York: Faber and Faber. p. 246

[14] Marranca, B. (1976). The "Sprechstucke": Peter Handke's Universe of Words. *Performing Arts Journal*, 1(2), 52-62. p. 52

[15] Winkler, T. (1998). *Composing Interactive Music: Techniques and Ideas Using Max*. Cambridge Massachusetts: MIT Press p. 12

[16] Dinkla, S. (1994). *The History of the Interface in Interactive Art*. Paper presented at the The ISEA, Helsinki, Finland.

[17] Griffiths, P. (2007). Europe 4: Mobile Form, 1956-1962 *Modern Music and After: Directions Since 1945* (pp. 104-115). New York: Oxford University Press.

[18] Motte, W. (1986). *OuLiPo: A Primer of Potential Literature*. Lincoln & London: University of Nebraska Press.

[19] Queneau, R. (1961). *Cent mille milliards de poèmes*. Paris: Gallimard.

[20] Aarseth, E. J. (1997). *Cybertext: Perspectives on Ergodic Literature*. Baltimore: Maryland: Johns Hopkins University Press. P. 10

[21] Winder, W. (1994). Le Robot-poète: littérature et critique, L'ère électronique Littérature, *Informatique.* (pp. 187–213). Limoges: Presses Universitaires de Limoges.

[22] Eco, E. (1989). *The Open Work*. Cambridge, Massachusetts p. 1
[23] Brown, E. (1970). *Panel Discussion: Notational Problems.* Paper presented at the American Society of University Professors 5.
[24] Welsh, J. P. (1994). Open Form and Earle Brown's Modules I and II (1967). *Perspectives of New Music*, 32(1), 254-290 p. 255
[25] Pasler, J. (2007). *Writing through Music: Essays on Music, Culture, and Politics,* New York: Oxford University Press. p. 38
[26] Zorn, J. (2004). The Game Pieces. In C. Cox & D. Warner (Eds.), *Audio culture: readings in modern music* (pp. 196-200). London: Continuum p. 199
[27] Hanoch-Roe, G. (2003). Musical Space and Architectural Time. *International Review of Aesthetics and Sociology of Music,* 34(2), 145-160 p. 155
[28] Cowell, H. (1996). *New Musical Resources*. Cambridge: Cambridge University Press. pp. 90-98
[29] Rathert, W., & Lum, J. (1989). The Unanswered Questions of the Ives Edition. *The Musical Quarterly*, 73(4), 575-584. p. 576
[30] Xenakis, I. (1970). *Persephassa*: Editions Salabert p. 14
[31] Neidhöfer, C. (2007). Bruno Maderna's Serial Arrays. *Music Theory Online*, 13(1), 1-16.
[32] Stockhausen, K. (1954). *Klavierstück XI*. Vienna: Universal Edition.
[33] Griffiths, P. (1995). *Modern Music and After*. Oxford: Oxford University Press p. 105.
[34] Read, R. C., & Yen, L. (1995). A Note on the Stockhausen Problem. *Journal of Combinatorial Theory* 76(1), 1-10. p. 5
[35] McElheran, B. (1965). Preparing Stockhausen's Momente. *Perspectives of New Music*, 4(1), 33-38. 8 p. 37
[36] Ibid. p. 34
[37] Xenakis, I. (1959). *Duel*, Editions Salabert, notes
[38] Zimmerman, A. *Xenakis' use of Stochastic Form*, from zimmermusic.com/downloads/papers/ Xenakis.pdf p. 17
[39] Xenakis, I. (1992). *Formalized Music*. New York: Pendragon Press. p. 127
[40] Ibid. p. 122
[41] Liuni, M., & Morelli, D. (2006). *Playing Music: an installation based on Xenakis' musical games*. Paper presented at the Working conference on Advanced Visual Interfaces, Venezia, Italy.
[42] Zorn, J. (2002). Sleeve notes from *John Zorn's Game Pieces Volume Two: Cobra*. . New York: Tzadik.
[43] Brackett, J. (2010). Some Notes on John Zorn's Cobra. *American Music*, 28(1), 44-75. p. 47
[44] Mandel, H. (1999). *Future Jazz*. New York: Oxford University Press. p. 172
[45] Brackett, J. (2010). p. 55
[46] Dubinets, E. (2007). Between Mobility and Stability: Earle Brown's Compositional Process. *Contemporary Music Review*, 26(3), 409-426 p. 412
[47] Gresser, C. (2007). Earle Brown's 'Creative Ambiguity' and Ideas of Co-creatorship in Selected Works. *Contemporary Music Review*, 26(3), 377 - 394 p. 378
[48] Yaffé, J. (2007). An Interview with Composer Earle Brown. *Contemporary Music Review*, 26(3), 289 - 310 p. 300
[49] Greschak, J. (2003). *Polytempo Music An Annotated Bibliography*, from http://www.greschak.com/polytempo/ptbib.htm
[50] Ghent, E. Programmed Signals to Performers: A New. Compositional Resource. In *Perspectives of New Music*. 6, 1, 1967, 96-106
[51] Ibid. p. 97
[52] Ibid. p. 103
[53] Ibid. p. 105
[54] Paxman, A. (2003). Hybridized, Glocalized and hecho en México: Foreign Influences on Mexican TV Programming Since the 1950s. *Global Media Journal*, 2(2).
[55] Barclay, L. (2009). *Liberating the Stave: Methods in notating live instruments with environmental soundscapes*, Proceedings of the Australasian Computer Music Conference 2009.
[56] Puckette, M. (2001). *New Public-Domain Realizations of Standard Pieces for Instruments and Live Electronics*. Paper presented at the 2001 International Computer Music Conference 2001. Havana/San Francisco.
[57] Battier, M. (2004). Electroacoustic music studies and the danger of loss. *Organised Sound* 9(1), 47 - 53
[58] Emmerson, S. (2006). In what form can 'live electronic music' live on? *Organised Sound*, 11(3), 209–219.
[59] Stockhausen, K., & Kohl, J. (1996). Electroacoustic Performance Practice *Perspectives of New Music*, 34(1), 74-105 p. 97
[60] Emmerson, S. (2006). p. 210