

Non-linear structures for real-time interactive musical works

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Abstract

Linear models for the organization of musical works, such as block-forms, Fugue and Sonata form, have a long and well-established history in Western Culture. Since the 1950s computer technology has increasingly been brought to bear upon the role of coordinating sound structures. The centralised nature of the computer's control of sound sources has permitted a compositional shift from pre-determined linear structures to ones that unfold in real-time - where the work's content is not tethered to the time and order of their appearance. This shift is mirrored in other mediums and their equivalent non-linear offshoots, notably literature (hypertext) and multimedia (hypermedia). This paper will survey a range of non-linear structural models and propose potential applications of these models for real-time interactive musical works.

1. Introduction

Linear models for the organization of musical works have a long and well-established history in Western Culture. The expansion and refinement of these structural models has to a degree been contingent upon concurrent developments in musical notation that allowed the abstract organization of progressively larger-scale ideas. What is not clear, considering that Western notation is unique in the degree to which it fixes the temporal and pitched aspects of a musical performance, is why European composers began to notate their work at all. One explanation advanced for the appearance of notation was the desire of the King Charlemagne to unite his 9th century Empire under a common religious practice. It is conjectured that musical notation was evolved to ensure a uniform interpretation of these melodies, legendarily transmitted to St. Gregory through divine inspiration. (Grout 1980 p.42) The melodies' consistency throughout Europe in this case would have represented an impressive validation of the authority of the Charlemagne's Holy Roman Empire to its new citizens.

Regardless of its origins the notated musical score altered the practice of music in Europe by permitting the synchronization of progressively larger numbers

of musicians over the following centuries and consequently the creation of complex pre-determined structures to be articulated in time. Theoretical frameworks to explain the reasons for comprehensibility in linear narrative accompanied this musical practice. Amongst the most common of these were paradigms derived from rhetoric: exposition – development – recapitulation. Structures developed for written and verbal debate were adapted from the Baroque period to create a logical framework for musical works. (Grout 1980 pp.459-460)

The linear logic of formal structures such as Fugue and Sonata form were in accord with the prevailing Newtonian empirical world-view. Their unified and orderly nature (departure and return to a tonic key etc) also reinforced the European political/religious status quo: which enshrined the Class System with divine authority. Equally the erosion of this system by the religious and political upheavals of the French Revolution was concurrent with erosions of the musical status quo such as Beethoven's experimental augmentations of Sonata form.

In the first years of the 20th Century the rapidly advancing developments presented a particularly daunting milieu for composers.

The contradictions in their music point to the fact that all the old certainties were evaporating. In physics, for example, Max Planck's 'quantum hypothesis' (1900), Albert Einstein's 'special theory of relativity' (1905) and Neils Bohr's model of the atom (1913) undermined Newton's theory that the world was stable and mechanically ordered. In psychology, Sigmund Freud and Carl Jung were showing that the mind was not as stable or as rational as had been previously thought.

(Hall 1996 p.2)

In a world where consistent predictable linear models were being increasingly challenged, non-linear formal models began to spring up across all artforms.

German Theorist Söke Dinkla traces one of the origins of non-linear formal structures to the late 18th Century with the invention of the panorama: a circular painting medium '*which encompasses the whole field of vision of the observer.*' (Dinkla 2002 p.27-9) The fact that the panorama (literally *all - to see*), developed almost simultaneously in England, France, Germany and the United States, suggests that it was a response to the spirit of the times. However its representation of a continuous horizon contrasted sharply with the prevailing single vanishing point perspective, and most distinctly with theatrical painting in which a central perspective assumed a single correct point of view '*reserved for the privileged position of the monarch in the royal box. The panorama changed this form of reception: it did not address an individual, but a large audience of up to 150 people, who could all observe the painting at the same time.*' (Dinkla p. 28)

Likewise Slovenian philosopher Slavoj Žižek argues that the developments in formal innovation and technological innovation are linked together.

Technology and ideology are inextricably intertwined... what we are dealing with here is yet another example of the well-known phenomenon of the 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 that will be able to serve as a more "natural" and appropriate "objective correlative" to the life-experience the old forms endeavoured to render by means of their "excessive" experiments. A whole series of narrative procedures in nineteenth-century novels announce not only the standard narrative cinema (the intricate use of "flashback" in Emily Brontë or of "cross-cutting" and "close-ups" in Dickens), but sometimes even the Modernist cinema (the use of "off-space" in Madam Bovary) – as if a new perception of life were already here, but was still struggling to find its proper means of articulation until it finally found it in cinema. (Žižek 2000 p. 39)

Similarly the dawn of the era of interactive cinema is today heralded by the emergence of linear motion-pictures with non-linear characteristics such as: the computer-game-like 'replay the game until you win' plots of *Groundhog Day* (Harold Ramis 1993) and *Run Lola Run* (Tom Tykwer 1998); the recursive or branching narratives of *Hana-Bi* (Takeshi Kitano 1997) and *Memento* (Christopher Nolan 2000); or the simultaneous multiple perspectives of *Timecode* (Mike Figgis 2000). It is arguably the theoretical activity at the convergence of technologies such as interactive cinema and computer games, that presents the most fruitful non-linear formal paradigms for interactive music. This paper traces the evolution of two non-linear paradigms that I consider may prove

fertile for the expansion of the formal repertoire for non-linear music.

2. A short history of non-linear music

Although the recorded history of non-linear works in music dates back to Mozart's sets of Minuets and Trios (O'Bierne 1967), in which the order of work's musical material is determined by coin tosses, more serious engagement with the idea did not resurface until the 20th Century in the United States with Cowell's Mosaic Quartet (1934) (Griffiths, 1981 p.118). In the post-war period, Cowell's ideas were explored more consistently by Cage and the New York School. Earle Brown in particular sought to musically emulate the mobile-form sculptures of Alexander Calder in a works such as *Four Systems* (1954). (Lange 1994 p.4)

In Europe the Darmstadt generation, through Cage's influence, also experimented with score-based non-linear scores. Notable amongst these works was Boulez' *Third Sonata* (1957-) (Griffiths 1978 p. 175) - a fully deterministic work with a large number of levels of variations in the order in which the material may be presented and some structurally important tempo flexibility. These variations range from large-scale re-arrangements of movements according to a 'constellation-like' structure to what we might today call hypertextual webs of connection between smaller musical fragments.

Stockhausen's music of the period also embraced these developments in a series of works that progressively explored non-linearity through: *Mobile Form (Klavierstück XI, 1957)* (Maconie 1990 p.76-80); variable variation of fixed scored material (via modifications on a movable super-imposed clear plastic strip) (*Refrain, 1959*) (ibid p.112-114) and the development of modified notation to allow the score to be played in any orientation (forward, backward or upside-down) and from any page (*Zyklus, 1959*). (ibid p.108-111).

The first steps into the new genre of interactive electronics, (generally thought to be begin Gordon Mumma's work for horn and electronics, *Hornpipe* 1967) (Winkler 1998 p.12), paradoxically appear to coincide with the conclusion of the exploration of non-linearity in notated works by major composers of the European Avant Garde (Stockhausen's *Momente, 1962-9*) and to some extent also the New York School (the end of Feldman's second graph notation series *In Search of an Orchestration, 1967*).

From the Seventies the focus of non-linearity in music shifts to non-notated music and the hinterland between Avant-Jazz and Avant-Garde Classical music. Significant contribution being made deriving from members of the Free Improvisation group Art

Ensemble of Chicago such as George Lewis, Wadada Leo Smith and Anthony Braxton and from the 'classical' side of the divide by composers such as John Zorn with his vast output of Game Pieces (27 between 1974 and 1992) such as *Klarina* (1974), *Hockey* (1978), *The Sand's Share* (1992) and the best known *Cobra* (1984) (Zorn 2002), that combined elements of Free Improvisation with game strategies (Ackley 1997). Interestingly in his investigation of Game Strategy Zorn is examining the same conceptual ground filmmakers such as Takeshi and Tykwer.

Non-linear works of this nature were restricted to musical idioms that could either make seamless transitions between the materials or that permitted discontinuities that allowed time for the performer(s) to coordinate which section they would play next. Like the 'excessive experiments' Zizek identified in 19th Century Novels, they may point towards possibilities for formal innovation in digital technologies to which they are more suited

In music, computer technology has increasingly been brought to bear on the role of coordinating complex large-scale sound structures since the 1950s. The centralized nature of the computer's control of sound sources has permitted a compositional shift from pre-determined structures to ones that unfold in real-time. Structures in which the work's contents are not tethered to the time and order of their appearance and which allow increasingly seamless transitions between materials. Theoretical frameworks to explain the implications currently proliferate. New Media Theorist Janet Murray points to the analogy of the 50 years that it took to develop the conventions that we associate with the book following the invention of the printing press. (Murray 1997 p. 28).

3. Some theoretical models of non-linearity

Before proceeding it should be acknowledged that the term non-linear is itself problematical since, unless the speculative theories linking the properties of sub-atomic particles to consciousness of Physicist/Philosophers such as Jean Charon (Charon 1983) are proven correct, all artworks are linear at least as far as the point of their articulation/apprehension in time. Time does not move backwards: we are free to chose – but only to choose what comes next, not to return to a previous state. So clearly we are only considering a kind of conceptual non-linearity – involving the potential to choose different paths, in comparison to a conceptual linearity – perhaps described as the hope that a performer will successfully negotiate determined musical events in the correct order from beginning to end.

It is this conceptual non-linearity that is also challenged by narrative theorists such as Paul Willemen:

There is no need to dwell on silly notions such as the digital media's alleged development of some form of non-linear narrative: narrative constantly loops back and branches out, condenses and proliferates uncontrollably, which is precisely why the 'meaning' of a story can never be fixed once and for all. Narrative was never linear, so to proclaim the discovery of non-linear narrative is absurd. (Willemen 2002 p.14)

However despite the truism that traditional narrative from Homer to Joyce 'constantly loops back and branches out', the narrative possibilities afforded by computers do alter elements of the narrative equation significantly: in particular the rate, degree, continuity and seamlessness of the transitions that can be made between narrative elements. Importantly it can also significantly change the conditions in which such transitions are made: by whom and how often.

In the case of time-based artforms - such as music, cinema and theatre - that are not physically 'in hand' in the way texts and paintings (etc) are, this last distinction has added weight, since it has not previously been possible for the viewer/listener to chose to 'loop back' or 'branch out', especially in real-time.

The degree to which this interactivity can create a truly seamless performance medium is perhaps more contentious. Future generations will likely regard the idea that our current state-of-the-art VR headsets or 5.1 sound diffusion could have generated a plausible simulation of reality with the same disbelief with which we today regard the fact that 'in the nineteenth century a number of (sic. painted) panoramic city views were created to save the educated middle-class from arduous travel' (Dinkla p. 29) or the well known anecdote that the first projected moving images of a train steaming down the tracks towards the camera caused cinema patrons to run for their lives.

3.1 The evolution of hypertext into a dramatic medium

Vannevar Bush: The Memex (1945)

It was in 1945, when the computer was barely invented, that Vannevar Bush proposed a method of organizing data "as we may think" (the title of his article). He proposed to call this microfiche-based machine, which stored information in an associative way rather than an alpha-numerically indexed fashion, the Memex.

It (the Memex) affords an immediate step, however, to associative indexing, the basic idea of which is a provision whereby any item may be caused at will

to select immediately and automatically another... The process of tying two items together is an important thing. (Dovey 2002 p.136) (Bush 1945)

Theodor Nelson: Hyper-link/text/media (1963)

Bush's concept was developed by Douglas Engelbart in the early 60s into the oNLine System - the prototype of the computer network - and the concept crystallized in the work of Theodor Nelson who expanded the capabilities for information sharing across a network and coined the terms hyperlink (1963), hypertext and hypermedia.

Nelson conceptualized the branching structure of hypertext and predicted its potential as a new literary medium.

The link facility gives us much more than the attachment of mere odds and ends. It permits fully non-sequential writing. Writings have been sequential because pages have been sequential. What is the alternation? Why hypertext - non-sequential writing.

(Dovey p.136) (Nelson 1999, p.121.)

The innovation of hypertext created a new way of traversing data. However its structural characteristic of placing all the data on the same level created problems from a narrative perspective: what dramatic force could draw a reader onwards through the links.

Umberto Eco: The Open Work (1963)

Umberto Eco provides a more generalized theory of Formal non-linearity in his book *The Open Work* (Eco 1977). Eco's concept of the open work encompasses a range of forms of 'Openness', to some extent encompassing the criticisms of Paul Willemen quoted earlier.

He identifies three forms of openness in the work of art:

- **Openness of interpretation.**

While acknowledging that all works of art are open to a degree of interpretation, Eco states that the open work '*is one in which there are no established codes for their interpretation.*' (Williams 2001) He cites the example of the fixed interpretative strategies of medieval literature compared to the '*field of possibilities*' of interpretation available for the understanding of Modernist works.

- **Openness of the Semantic content.**

Eco identifies the existence of ambiguity of meaning caused by semantics issues. This form of openness is particularly pertinent to writers such as Joyce and Shakespeare who frequently create their own vocabulary of words with multiple etymological roots that may interact to create knots of varied sub-meanings.

- **The "Work in Movement"**

The final form of openness identified by Eco encompasses works in which the components are mobile such as hypertext. It also envisages the possibility of works that are presented 'in-progress' or without conclusion. He also makes it clear that boundaries still exist for such a work '*the "work in movement" is the possibility of numerous different personal interventions, but is not an amorphous invitation to indiscriminate participation.*' (Eco 1989 p.19)

Together these three forms of open work outline a new approach non-linear narratives in which the:

'structural vitality is still seen as a positive property of the work, even though it admits of all kinds of different conclusions and solutions to it.'

(Eco 1989 p.20)

New Media Theorist Söke Dinkla suggests that Eco's term is inadequate to describe art based on a network concept. She proposes the term '*floating work of art*' to encapsulate the way in which '*the conventional characteristics of traditional works, as well as the boundaries between different layers of reality and concepts of the subject are now in flux.*' (Dinkla p.34) This term is sometime used interchangeably with 'liquid narrative'.

Roland Barthes: Cardinal Functions (1977)

French Theorist Roland Barthes went some way to establishing a new grammar for the 'work-in-movement' through an abstraction of basic narrative principals. He defined these as Cardinal Functions: Nuclei - elements that are logically essential to the narrative action and Catalyser - the narrative strategies that propel the discourse through the basic chronological story events (such as Framing, Flashback, Anticipation .etc): Reiser paraphrases Barthes to summarize the functions of these elements:

- *Nuclei are both consecutive and consequential*
- *A Catalyser accelerates, delays, gives fresh impetus to the discourse*
- *The catalyser ceaselessly revives the semantic tension of the discourse, says ceaselessly there has been, there is going to be, meaning*
- *A nucleus cannot be deleted without altering the story, but neither can a catalyst without altering the discourse*

(Rieser 2002 p.148 from Barthes 1977 p.95)

Reiser notes that '*most interactive hypertext fictions tend to be a collection of ... 'cardinal functions' or narrative hinge points, without the necessary indices and catalysers which add depth and flow to the narrative.*' (Rieser 2002 p.148)

Gilles Deleuze and Felix Guatarri: The Rhizome (1976)

French Theorists Gilles Deleuze and Felix Guatarri focused on the concept of the “work in Movement” proposing that the Botanical term for a root-like stem emitting roots – the Rhizome – was a good analogy for this new formal structure. They expand the concept as a revolutionary world-view with almost Manifesto-like zeal in their work *Rhizome*, which was later incorporated as the introduction to their volume *A Thousand Plateaus*.

The rhizome itself can take all sorts of different forms, from the branching out in all directions on the surface to the compression into knots... any point of a rhizome can be connected to anything other, and must be.

(Deleuze and Guatarri 2002 p.7)

Zizek characterizes the ‘hypertext rhizome’ as being a structure that:

‘does not privilege any order of reading or interpretation; there is no ultimate overview of "cognitive mapping", no possibility to unify the dispersed fragments in a coherent encompassing narrative framework.’ (Zizek, 2000 pp.37)

Janet Murray: The Violence Hub (1997)

Zizek’s identification of the impossibility of unifying a hypertext rhizome into a narrative framework would seemingly diminish the dramatic possibilities of this formal structure: rendering it a formless, meandering and literally interminable. But paradoxically the dramatic possibilities of this form may lie in the very fact of its inherently irreconcilable nature. Zizek presents the potency of the unresolvable hypertext rhizome in Lacanian terms as drawing on:

‘the trauma of some impossible Real which forever resists its symbolization (all these narratives are ultimately just so many failures to cope with this trauma).’ (Zizek 2000 p.38)

Murray succinctly summarizes this dramatic potential in a formal structure she has termed the ‘Violence Hub’. It refers to works in which each possible hypertextual pathway examines a central irreducible event from a different perspective.

The proliferation of interconnected files is an attempt to answer the perennial and ultimately unanswerable question of why this incident happened. These violence hub stories do not have a single solution like the adventure maze or a refusal of solution like post-modern stories; instead they combine a clear sense of story structure with a multiplicity of meaningful plots. The navigation of the labyrinth is like pacing the floor; a physical manifestation of trying to come to terms with the trauma; it represents the mind’s repeated efforts to

keep returning to a shocking event in an effort to absorb it and finally, get past it. (Murray pp.135-6)

Murray’s ‘violence hub’ paradigm is a clear example of a ‘Dramatic’ non-linear formal structure. The paradigm can also be applied to hypertextual forms that are driven by hermeneutic codes, in which the narrative is driven by the desire to solve a question or riddle, such as detective stories or some computer games. The inquisitive narrative genre in the form of the ‘Mystery’ and later the detective story evolved during the Victorian Era. A hypertextual format not only allows a non-linear approach in which ‘clues’ can be gathered in any order, but also the possibility of multiple or non- solutions. For example a reader’s individual predilections for certain types of clues might lead them to varying conclusions.

This quality, the trauma of the ‘Real’ which resists its symbolization, also makes it an ideal form for a live performance context rather than more common browsing and installation-based applications of hypertextual structures. At present it may be the best model for a hypertextual ‘catalyser’ capable of propelling a hypertextual non-linear narrative.

3.2 Multiple Perspectives

Multiple perspective non-linearity can perhaps be seen an extension of the cinematic technique Montage - thought to have been developed by Edwin Porter and D.W. Griffith in the 1910s. The technique was evolved by film-makers such as Maya Deren who explored the idea in her films *Meshes of the Afternoon* (1943) and *At Land* (1944) as a means to create a fusion of subjective and objective reality. Deren also developed the practice of moving the position of the camera/observer - traditionally fixed until that time: what she termed ‘the dance with the camera’ (Dinkla 2002 p. 32). The juxtaposition of narrative sequences in Montage combine to form an integrated meaning: the hackneyed newsreels and champagne corks popping to establish a roaring success; or more complex outcomes such as Deren’s works. However, in the case of the disparate irreconcilable strands of multiple narrative, they function *because* of their lack of integration. We see, as it were, the same world through different eyes. One of the best examples from the early Modernist era is William Faulkner’s novel *As I Lay Dying* (1930), essentially a collage consisting of stream-of-consciousness narratives delivered by 15 different characters spread over 59 chapters. The changing perspectives of each narrator deepen out understanding of the motivations and shortcoming of the others.

Conceptually the multiple-perspective narrative can be seen as the flipside of the kind of single pathway non-linearity that characterizes the hypertext

rhizome. Rather than consisting of a single path that may alter course at any fork, multiple-perspective non-linearity requires a number of paths with distinct identities from which the participant can choose. The single path may include surprising jumps or juxtapositions that the participant is forced to accept with a kind of existential contingency, whereas the identity of each multiple-perspective pathway is crucial to the formal structure: it must be possible to recognize the characteristics of each path in order to that you understand that you have you have indeed changed paths.

Although we are familiar with seeing things from different perspectives even ones that we are unsympathetic to, such as those of the anti-hero, normal consciousness presupposes a mostly unified world-view. Consequently multi-linear works are capable of creating tension through the incongruity of the perspectives presented. A recent example of the ambiguity multiple-perspective can create is found in Figgis' film *Timecode* (2000) which presents the events of the same 90 minutes to its audience on a split screen from four different cameras' perspectives. Through refraining from directing the audience to a single point of view Figgis achieves a level of moral ambiguity highly unusual in mainstream cinema. In one sequence on four screens we simultaneously see pivotal action that can be summarized to two narrative threads:

1 st Narrative Thread	2 nd Narrative Thread
Two women in a car fight over the younger woman's fidelity. (She is an aspiring film-actress)	A Film Director at a film studio pathetically drinks and fights over the phone with his ex-lover
The younger woman angrily leaves the car for an interview at the studio	The younger woman leaves the car and arrives at the Studio reception
It is revealed the older woman has placed a bug in her lover's purse.	Inside the Studio the younger woman meets the Director.
The older woman listens in remotely via the surveillance device. Her reactions reveal she cannot distinguish between the dialogue from the film screening and the real conversation	The Director takes the younger woman to a screening where she immediately flirts with him. He does not resist her advances. She leaves the purse at the front of the theatre they retire to the back of the theatre.
The older woman listens in anguish to sounds of love-making via her lover's bugged purse.	In the Screening's 'film-within-a-film' a couple begin to noisily make love

In the particularly ambiguous climax of this sequence we see what the older woman only hears – the abandoned handbag in a screening theatre that is screening rushes of love-making scenes from a movie, we also see that the soundtrack masks the real sound of the director and the unfaithful lover's actual

sexual encounter. The ability to view the events from the point of view of each principal character has the strange effect of rendering us neutral or ambiguous in our sympathies and our position in regard to the morality of each character's actions.

Rieser: Multi-linear Scripting (1997)

Martin Reiser's interactive video work *Labyrinth* (1997) used parallel streams of video which the interacting audience could switch between. The monologues recorded on the videos featured two opposing narrators Theseus and Ariadne and allowed the audience to 'reconstruct a meaning somewhere between' them. (Reiser 2002 p.152)

The development of irony and pathos demanded that no single monologue is privileged. Writing for such an interface involved a new and precise multilinear approach to scripting. (ibid p.152)

In comparison to other artforms the temporal organization of music is generally more densely distributed and the temporal relationships between its components – its rhythms – are also generally more central to its identity. Therefore the degree of coordination between the streams is arguably more even crucial, than for example the timing between lines of dialogue. Multiple-perspective non-linearity offers a particularly useful model for music, especially in the case that the vertical synchronization of lines is crucial, in that it allows for the possibility of retaining synchronization between paths even when they are not audible.

4. Some possible models for non-linear musical works

4.1 <as viewed from above>

As discussed elsewhere, (Vickery 2002) my first venture into developing a new formal structure based on 'hypertext rhizome' model was <as viewed from above> a work for soloist and pitch sensing Max/MSP software. The principal structural feature of this work was a short fragmented text executed by the computer in response to the soloist's improvisations. Many of the formal innovations discussed in this paper concern text works and dramatic works - particularly those that are image-based and <as viewed>'s text-based structure shows its conceptual lineage in this regard. The element of abstraction in sound however is notoriously resistant to formal analogies based on visual and text-based narratives. (Sonata Form is one notable exception). The difficulty seems often to be creating rules for a musical work that are at once simple enough to be understood by the listener and complex enough to maintain their interest. Some solutions to address these problems are proposed in the next example.

4.2 Ladders and Snakes

Linearity in text or images can generally be regarded as more self-evident than in music. In the case of the technique of Flashback in film for example, there are usually many clues to alert the audience that they are observing an earlier time: the characters are younger or dressed in clothes of an earlier time or perhaps suddenly returned from the dead. In order to develop the same kind of linear logic in a musical work it would be necessary to present musical parameters that are changing in a way that is predictable and linear enough to be deduced by the listener before any discontinuities occur.

In my work in progress (currently titled) *Ladders and Snakes* (2003), a linear logic is established by the progressive widening of a number of parameters (broadly speaking: pitch, timbre, spacialization and rhythmic activity) over the duration of a several predetermined sound-file 'lines'. At various nodal points the computer/conductor may choose to place a 'ladder' or 'snake' in the path of a line – causing it to either ascend a 'ladder' and jump to a later section in the sound-file or to descend a 'snake' back to an earlier section.

It is also possible to conceive of a realization of the work for acoustic instruments in which performers' tempo and position in the score is controlled by a computer click-track. Instead of a single 'expanding' sound-file, the players realize a score that is for example, progressively: wider in range; contains more pitches; is more rhythmically active etc. Since the score is read top to bottom as opposed to the board game or sound-file, the live performers' 'ladders' *descend* to a later section and their snakes *ascend* to an earlier one. In either case the listener is able to determine the computer's choices/formal structure ie the state of the game by the incrementally more complex nature of the musical material throughout the work.

4.3 Splice

In my work for live sound and Max/MSP *Splice* [2002] I employ synchronized live sampling to impose a formal structure on an improvising musician. It is an example of an encoded 'meta-music' - that is a compositional map that is without contents until a live performer adds them. *Splice* sculpts all sounds into the same structure regardless of whether they are melodic, noise or even silence, so though it may sound different (ie have different contents) each time its is always the same shape. It functions formally by dividing sounds sampled from the soloist's performance into up to five additional lines. Its processes are simple, even primal, in an effort rapidly to build a recognizable and generic musical syntax: namely repetition, augmentation, diminution, transposition, but are controlled by algorithms complex enough to be difficult to accurately predict.

The performer's position is slightly at variance with the traditional interactive paradigm. There is no possibility to control or even to precisely comprehend the computer's processes. Even if the computer's processes could be understood, the fine time-grain of musical discourse would still make it impossible to exactly synchronize this understanding with the live performance. The computer's processes operate in a sense like Zizek's '*Real resisting its Symbolization*'. Instead the performer must, like Murray's hypertextual '*multiplicity of meaningful plots*', continue to attempt to provide material in an effort to increase the work's coherence. This material has also to be presented in conjunction with ongoing products of computer's processes. The performer is both in control of and subordinated by the computer at the same time, there is a balance between predictability (the computer is only capable of playing material that the performer has provided) and surprise (when and how the material will re-emerge is only possible to predict in broad terms.) In this sense *Splice* recreates a state of affairs very similar to improvising with another musician.

4.4 Parallel Trajectories

Parallel Trajectories [2003] for a quartet of live instruments and Max/MSP explores the potential of the multiple-perspective narrative as a paradigm for musical organization. Like Reiser's multi-linear scripting work *Labyrinth* it is a made up of a number of compatible lines and nodal points at which players may jump from one line to the next.

The impetus for this work was a consideration of the act of choice that is inevitably involved in the creation of fixed notated music. No matter how detailed the plan for a composition, there always remain decisions to be made at the notation stage that cause the music to take one particular path rather than countless others. The uneasiness caused by this narrowing of possibilities has led me in the past to various alternative solutions: non-linearity, repeated reworking of the same material or developing a performance practice fine details for the piece in rehearsal for example.

In *Parallel Trajectories* the performers are presented with a score map containing a number of different paths from start to end. The piece is linear and at a fixed tempo, but each performer must make choices about which pathway to take at any of the score's nine nodal points. There are five choices possible at each node: three notated staves (paths) of music, to improvise or to be silent. As with a text or image multiple-perspective work, each staff/path has a distinct identity in terms of the degree of activity, conjunct/disjunct movement and register. The computer part synchronizes the performers, takes note of which path each player is performing and

'plays' any absent parts/paths. It performs the absent part by generating a hybrid instrument from the average combined harmonic spectrum of the live instruments. The result is a work that should always sound similar but never the same - a map to allow players to discover perspectives on the same territory with each performance.

5. Conclusion

Non-linear organization of information is increasingly prevalent and the ramifications of this form of organization are beginning to transform the way mainstream media are presented. The exploration of non-linear forms is proliferating from the realm of high-art subcultures into the mainstream particularly through film, television, computer-games and computing in general. The idea of effective 'dramatic' structures based on non-linearity goes against Western Arts theory and practice that has existed since Classical Greek times. It can be expected that the development of successful new strategies may take a significant period of time. Janet Murray's 'Violence Hub' and multiple perspective non-linearity present two potent paradigms for organization of interactive non-linear works.

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