Beyond Pitch/Duration Scoring: Towards A System Dynamics Model Of Electroacoustic Music

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Based on a hierarchy of discrete pitches and metrically sub-divisible duration, Western tonal art music is usually modelled through printed music scores. Scoring acoustic musical events beyond this paradigm has resulted in non-standard graphs in two dimensions. New digitally generated 'soundscape' forms are often not conceived or understandable within traditional musical paradigms or notation models, and often explore attributes of music such as spatial processing that fall outside two-dimensional graphic scoring. To date there is not a commonly accepted model that approximates the structural dynamics of electroacoustic music; providing a conceptual framework independent of the music to the degree of standard music notation. Based on recent work in spectro-morphology as a way of explaining sound shapes, a systems dynamics model is proposed through mapping a dynamic taxonomy for structural listening as an aid to composition. This approach captures formal but not semiotic discourse.

Given that non music specialists may bring a wide range of musical experiences to the conference, a broad background and context for the idea is first provided.

Western 'art music', particularly since the Renaissance to 1900, was based on a theoretical system of tonality and rhythmic symmetry. This language is now commonly reproduced in unique patterns based on familiar language in contemporary western popular music. As a tonally based art form, pitch and duration were the two foremost quantitative attributes of this language. The associated notation system focused mainly on recording these aspects of it. The conventional five line staff and bar lines are a reflection and part of this.

Pitch/duration based music evolved dialectically with a set of compositional techniques expressed through chords, scales and keys. The development of small motives through augmentation, diminution, transposition and inversion in the context of major and minor modes, and structural based key contrasts, was central.

Despite the change in theoretical base with the decay of tonality around the turn of the century, discrete pitch and duration have remained a significant part of western art music (Dallin 1957). Abandoning tonality did not undermine many established compositional techniques, or the method of scoring. If anything, music became more formalist, particularly in extreme serialist methods of composition, where all aspects

of music were attempted to be made subservient to notation (Cope 1993, Fink et. al. 1975).

Central to pitch/duration scoring is the notion of a score as a guide to performance from a player and conductor's perspective. A score is then a script but not music. This script captures only some aspects of the music: the detail of individual parts, the orchestration, dynamics, phrasing, and the sequence of events. There is much that needs added by performers to make these parts sound musical, and by a conductor to balance the sound and manipulate the temporal content.

The score then does not record many aspects of performance. It can also not approximate the listeners' experiences based on commonly shared musical metaphors, or overtly the underlying structural dynamic intended by the composer.

The advent of electro-magnetically recorded sounds contributed to changes in music conceptually as the result of the new method of storing music (Alec 1995, Borwick 1993, Worman 1982). Recording captured the performance rather than the script. The result in popular music was to make particular performers central to a piece of music. Recording made *a* performance *the* authentic music, making all aspects of the music legitimate as text. The medium of authenticity then changed from visual to aural. Yet aspects of the performance could however still be notated, as sales of sheet music testify.

On the basis of this new technology a new music aesthetic developed through the use of multi-tracking recording and analog synthesis. Scores could be constructed that were unable to be performed live. This was music for reproduction rather than performance.

A significant aspect of this shift, particularly in context of popular music, was that although aspects of the music were still able to be recorded within pitch/duration notation, and performance captured through recording, increasing aspects of production were not notated independent of the score or recording. After the fact, an interview with a producer may give insights into what had taken place, but this did not often approximate the use of techniques in real-time or the dynamic interplay between them.

New music/new scoring

The revolution in recording and production, in tandem with the development of modernism in western art music, led to the development of the electroacoustic music idiom based in analog technology (Chadarbe 1997, Dobson 1993, Emmerson 1986). Central to this approach was the studio as instrument, the intention of *reproduction* rather than performance, and the lessening of the focus on pitch/duration . What was largely not an issue was the abandonment of tonality as the basis of musical language.

Although digitally based, the idiom continues today in editing based approaches to music construction. Timbral transformation, the incorporation environmental sounds, and micro-tonal textures still typify the idiom (Vaggione 1994 & 1996, Waters 1994).

Rather than being referenced to instrumental performance gestures, it often reflects more slowly evolving environmental gestures (Smalley 1997). The dislocation of sound source from performance results in context rather than absolute reference being able to define the musicality and authenticity of sound.

Real-time processing of sonic space makes this idiom unique through the manipulation of the horizontal plane of listening (pan) and presence/distance (reverb/delay). Individual parts can then be processed separately to create the illusion of a multi dimensional dynamic space. Space can then be used in composition as a structural element (Smalley 1996).

Electroacoustic music then, rather than being referenced to an external theoretical system of tonality expressed through pitch relationships and based in the syntax of instrumental and vocal performance and gesture, is based on timbre. The detail of a sound object, its context or location, are established within a piece. This shift from an external absolute through tonality to an internal one is significant. The stage on which the music is understood and played out is the imagination, rather than against an external intellectual construct (Rudy 1999, Menezes 1997, Balaban 1996).

Since its inception, different composers have attempted to score electroacoustic reproductions in visual equivalents. This has largely involved the use of drawings that showed the pitch on the vertical axis and events on the horizontal axis. The micro-tonal nature of many scores meant that only broad gestures could be approximated. Much of the time these scores were of little use except as a broad guide to the structure of the work, and they served as a guide to frequency spectrum listening (Cogan 1984). Similar attempts have been trialed using spectrum analysis and graphing the output with software packages. Some new software based micro-tonal synthesiser generators use a similar approach, but some also add colour to indicate left and right spatialization, and brightness to indicate volume.

The problem and approaches

Non of these methods are able to fully approximate the music. Music is a dynamic art, the method of representation is static. Besides, the only successful way to model a piece of music in entirety is the actual music.

In electroacoustic music the composer generally works directly in sound, bypassing the need for a score. An electroacoustic 'score' generally is more likely to be a set of sketches and notes for a piece that are largely inaccessible to all but the composer and a few initiates. The *listeners'* experience of the music is often quite different from these sketches, and different from the composer's techniques of arriving at particular sounds and sections of a composition.

Compounding this is the seductive nature of digital technology in the composition process (Roads 1996). The precision that the equipment now offers makes concentrated listening to detail possible through repetition. This facilitates composing at a micro level but often neglects the fleeting nature of material in context, and the larger picture from the listeners' perspective.

The learning curve for the technology also adds to composer/listener distance, at times allowing the impression that something is musically significant because of the complexity of the process of arriving at it. Additionally, the technique of producing music does not often have a direct correspondence to psycho-acoustic response: increasing the volume is often not interpreted linearly by listeners for example.

At a macro level, a composer may graphically draw the overall structure of a piece as a guide for listening. Yet while identifying sections and form, this often fails to identify the temporal dynamic of a work. Besides, mapping form as score backs one into the formalist proposition of meaning being the score itself, and negates listening experience as a valid basis for interpretation: the continuing dilemma of musicology.

To fully capture the listen experience is a daunting task. Music is a metaphorical art form and individual responses to a work may vary widely. The gambit of response is narrowed in idioms like film music where through mutual implication with a visual image there is a guide to interpretation based on cinematic and cultural musical coding, or in popular music where the words act as a guide to interpretation (Gorbman 1974). Without a parallel guide, the music *is* the main focus of attention, and responses are likely to vary widely.

Why then model this new art form? As a composer and lecturer in this idiom one recognises the increasing gap between the experience of composing and the listening experience of a non initiated audience. Although not a unique problem, compositional intention and the results from a listening perspective often differ far more significantly here than in traditional pitch/duration idioms. A model that approximates any aspect of reception may then aid in bridging this gap and aid composition. Of course, this is based unashamedly on the notion that a worthwhile aim of composition is to establish a knowledgable dialectic with an audience, not a fashionable notion in some quarters.

What can be modelled? As stated, the metaphors of reception are problematic because of non-specificity, unless the composer has built the piece on a narrative that can be related, or a poem that lays out the intention (Landy 1994, Norman 1994). Besides, metaphorical diversity is the province of musical communication. Yet the dynamic flow of events that underpins and is an integral part of the structure of the work is something with a common referent: time.

Modelling the dialectic between structure and event within a temporal framework would give the composer one indication of the way a work may be received by an audience. By concentrating on relationships rather than objects this partly avoids the formalist proposition by making listening as interpretation an essential part of the composition process.

The approach is by no means foolproof, but a step towards overcoming the problems outlined. For this new art form it is of further significance. Works, being largely self - referencing, enact their dynamic individually through first establishing a base level of activity and material against which events are played off. In these terms, modelling the dynamic of conventional music differs because it is played out against a theoretical musical model that is commonly accepted and understood.

In arriving at this position, systems dynamics software seemed a suitable vehicle to illustrate the proposition. A cursory search for literature on systems dynamics and music revealed little, and local systems dynamics experts could see little connection. On a recent discussion list when answering an enquiry on systems dynamics and piano pedagogy, the only respondent remarked that 'As a serious musician and system dynamicist, both for more than 25 years, I believe they have nothing to do with each other' (Richardson 1999).

I believe that the link is profound. Music is a time based art form grounded in the experiential flow of events and relationship. In this sense it is similar to other narratives. In television dramas we repeatedly witness the formulistic narrative pattern of introduction, complication, climax and resolution, yet we still revel in the detail of specific characters, relationships and inter-relationships. Abstract music as narrative deals with a similar dialectic, except it is played out not through verbal/visual discourse, but through aural/physical discourse. Although both are kinetic art forms, the difference is that stories deal with the explicit; music is the province of the implicit. A sensual rather than conceptual art form, its province is persuasion and seduction rather than opinion and reason.

Music is then both history and speculation without words, and dance without dancers. It provides in the dynamic opposition of unity (repetition) and variety (novelty), the vicarious experience of pleasure and disorientation. As pattern seeking creatures, people delight in the significance of music as a sequence orientated cure for bewilderment because it provides *meaning* and *certainty* at an implicit level.

The mapping of narrative structures incorporating feedback loops is a main feature of systems dynamics. Software packages such as *Stella* have already been applied to understanding the structure of plays and novels to provide insight into a work. The mapping of Hamlet's dilemma as the structural basis of the play provides a fitting example. (Hopkin 1992). Similarly, the psychology of perception is also fertile ground for this tool.

Towards a systems dynamic model of electroacoustic music

In working with student composers in the electroacoustic idiom, a common fault is their not being able to grasp how the many aspects of a work will integrate and inter-relate in real-time from a structural dynamic perspective. A consequence is often becoming bogged down in detail and losing the larger picture on one hand, and in attempting to regain it with older graphic scoring methods, complication being added through further detail. In addition, breaking down music to its fundamental elements (frequency, tempo etc.) often lays bare what music is made up of, but not what elements do in the context of themes in real time. The lack of facility to play 'what if' interactivity with *structural* problems is then a major stumbling block.

The control of the structural dynamic of a work based on the manipulation of the unity and variety of thematic material is the cornerstone of the development of compositional technique in music generally. Without a systematic and explicit way of illustrating this in real-time, acquiring this skill in electroacoustic music is usually by

trial and error; or through the use of tunes, importing aspects of dynamic control from the external referent of tonality, where this control is more widely documented and understood.

An alternative is the critics' dilemma of describing structure through verbal/logical modelling, or poetic metaphor: 'The brooding and sparse beginning builds quickly to climax built on the yearning opening motive' for example. The idea is seductive superficially, yet mixes semiotic response with dynamic control. A map of dynamic real-time control then isolates one aspect.

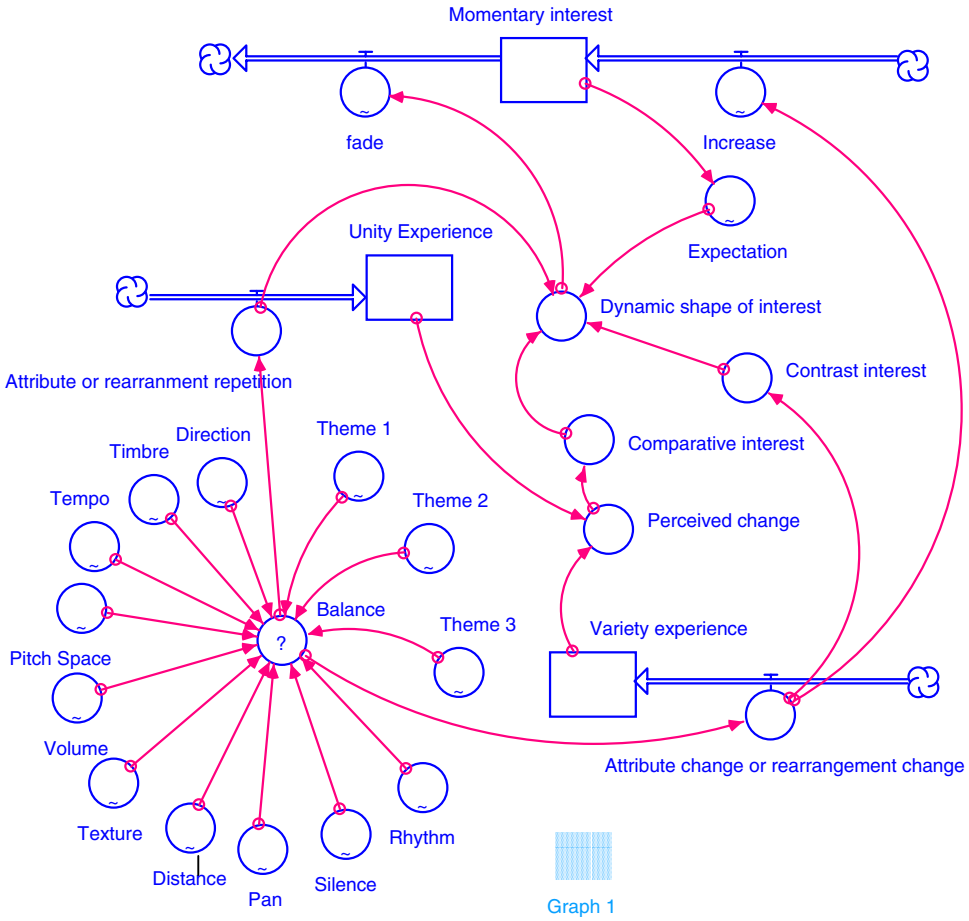
Basing the systems dynamics model on listening may seem an ultimate solution initially. Yet this begs the question of 'which listener' and 'listening to what'. The quality of listening can depend on the level of attentiveness and the knowledge of music brought to the situation. What people listen too can vary widely regardless of attention. It may also be difficult for many people to separate different aspects of music into specific parts.

The systems dynamics model proposed here is then based on three assumptions: that music as *structure* is a representation of the existentialist experience of time (Imberty 1993, Kramar 1988); that this experience is only knowable through the *perception* of sound events; and that the mapping of these events inter-actively in real-time will approximate the experience. By mapping statement, uniqueness, repetition and variation in the context of the dynamic interplay between unity any variety, climax and resolution, how the structural dynamic of the piece was arrived at can be revealed.

A limitation here is the assumption that all listeners will be as fully cognisant and musically attentive and informed as the composer. They must also have perfect musical memory: the ultimate audience! This is the assumption historically most western art music composers have made. This perfect state in relationship to the piece may be arrived at through a number of hearings, and the process may be a long one. For example, one can still find new insights into Beethovan's work after fifty or more renditions.

One model of electroacoustic music is given below. The overt structure is similar to psychological models of happiness (McHugo 1992). The detail and internal dynamic established in the relationship between parts is unique to music. The *dynamic shape of interest* is the end point, and the assumption is a perfect correlation between this and the contour of *tension and relaxation* in the piece. The model therefore incorporates the perfect listener.

Figure 1

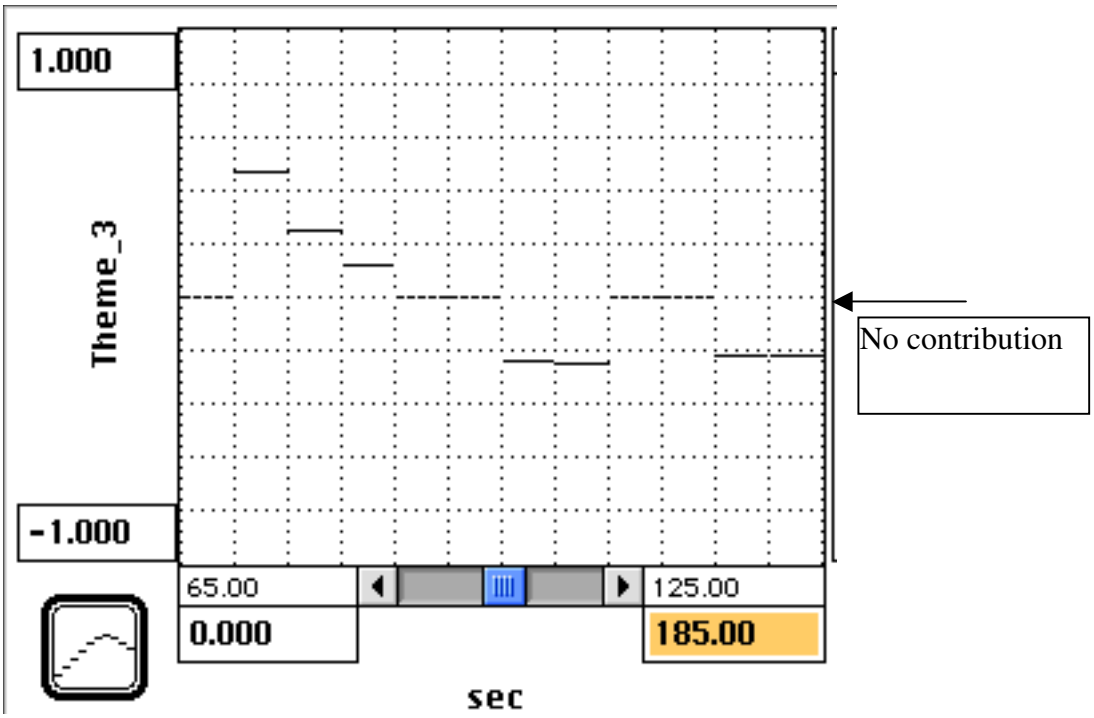


The two main drivers in any music are the tension between unity and variety. They are based on two main types of change, or statis if they are continued or repeated: *Rearrangment* change where time is expressed though motion or changes of position in unchanging sound objects. For example, through notes or recurring sound complexes; and *attribute* change in which time is expressed through change in the attributes of sound objects, such as parametric alterations in the qualities of a sound object (Pressing 1993, 113).

The elements of music that may contribute to this change, variation, repetition or continuation are included at the left-hand side of the diagram. Each event and element is mapped graphically as contributing to unity or variety throughout the piece. The graphs are drawn so that each time frame is decide based on what information has already been presented. A negative movement indicates a contribution to unity, and a positive to variety. Zero means there is no contribution either way (see Figure 2).

The model relies on composers being able to auralize individual elements in the first instance, or map them in after the fact. The subjective nature of this decision as to the contribution of parts is the essense of structural control as composition.

Figure 2



Not all musical elements and themes will be present at the same time, and different clusters of elements are likely to be more present at some stages than others. Some may not be manipulated at all.

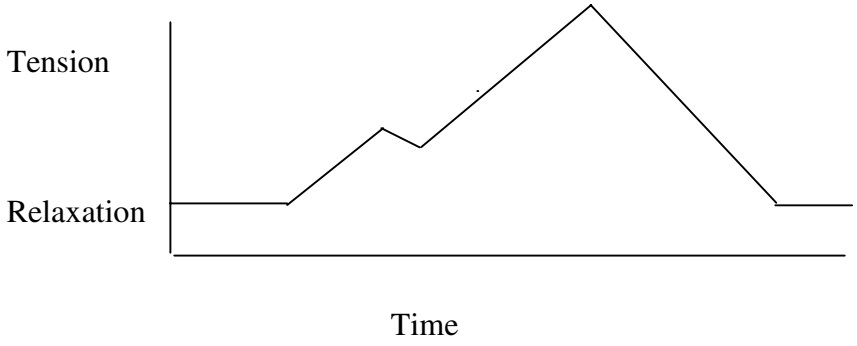
Through this method one can quickly grasp how themes contribute to unity/variety relative to each other, rather than the overall dynamic. Combinations such as depth verses pan are difficult to map by other means, or their contribution illustrated in the context of the whole.

The diagram allows for three main thematic elements, the weight of each being mapped to unity and variety. Any number could be added here. The approach allows for the introduction of the piece to establish the frame of reference against which later elements will be played off.

The right hand side of the diagram maps the adaption dynamic or the way change or rearrangement provides interest but also partly undermines interest. Some of the assumptions made here on the quality of the underlying relationship may have to be altered depending on the piece being modelled.

An ideal *dynamic shape of interest* in a classic sense would be an undulating variation of the graph below. This is the shape of most classical and popular drama, large scale western art music, and popular song.

Graph 1



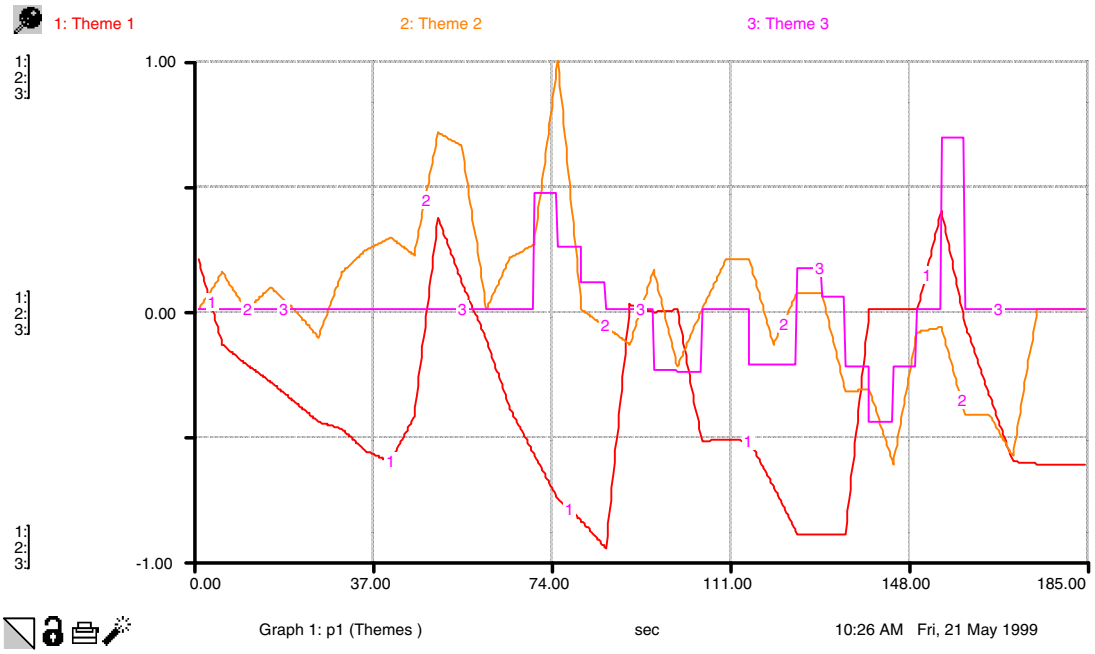
The tension line is developed so that the climax is about two-thirds to three quarters the way through within the framework of introduction, complication, climax and resolution; or musically, introduction, variation, contrast or development, and recapitulation.

Of course, not all works follow this dictum and once the control of structural dynamic is gained, composers and authors often delight in playing with structural expectations. Electroacoustic music composers are no exception, and the nature of some pieces actively set out to undermine the conventional dynamic (Chadarbe 1996). But this is usually undertaken being fully cognisant of the tension between the expectation of events and the reality of a piece.

Example

The simulation based on Figure 1 will be run at the conference. The musical demonstration presents one interpretation of this (Whalley 1998). There are three clearly contrasting themes: natural, electronic and melodic. Spatial processing (pan /depth) is central to the piece, used mainly to vary the limited thematic material. The model has an unconventional dynamic shape in that the second climatic point undermines the first, giving a reversed dynamic in which structural interest dwindles. This is a typical compositional problem students face. The relationship between the thematic material is mapped below. The internal relationships in Figure 1 have been adjusted to reflect the intention of a classic dynamic.

Graph 2



Conclusion

The relationship between systems dynamics thinking and music is then, far from being obtuse, integral and significant. The model proposed outlines one aspect of this.

There is a danger in thinking that this approach to music can be all encompassing. However, as stated, it works by negating a semiotic response to music, a response that is an essential part of appreciating music on a *poetic* level. In electroacoustic music, the manipulation of sound objects often have a real world referent that composers use as a basis for metaphorical and symbolic discourse. It is this aspect of the music that often engages non initiates at an emotional and subconscious level. In contrast, a work may have an interesting structural dynamic, but if the composer has no control of semiotic discourse, be a maze of metaphorical confusion.

A further limitation of the model given here from a compositional perspective is technical. One may have an idea of how something may need to change on the diagram, but not have the production skill or musical sense to translate this into sound. Similarly, one may have good structural ideas but no sense of detail. There are many literary critics with a good understanding of structure who are unable to write an engaging novel. Musical craft is one thing; original ideas at sometimes another.

In this sense, the model is proposed as a tool, not an end. It is a way of visualising an aspect of music that is difficult to see by other means, and affords experimentation with different approaches as an aid to structural expression once one has some basic

ideas. Its limitation is the assumption that a systematic approach to musical structural dynamic is worthwhile: not a universal notion (Chadabe 1996).

It is seductive to think that further work might include the mapping of music directly into the model, but the approach is fraught with problems in separating parts aurally, and in translating the sound material into psycho-acoustic response. The question remains here if the effort is going to yield a result that is anything beyond entering the input graphically by hand, or be any faster.

Others have argued that the ideal reception of music is neither structural or metaphorical, but lies in the dialectic between the two (Milicevic 1998). The model here then presents a glimpse of the story. The metaphorical mapping of the semiotic discourse is something I have begun to attempt based on current broad taxonomies of emotion. Whether the linking of structural and metaphorical models reveals any new insights remains to be seen.

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