

This paper examines modelling aspects of the process of creating computer music using system dynamics tools. It provides a way of visually simulating ‘what if’ outcomes based on a thematic approach to composition. Two grounding assumptions here are that the creation and control of dramatic tension/shape is a worthwhile pursuit in narrative art forms; and that there is a need for computer music composers to communicate with audiences beyond the academy. Simulations based on the approach will be run at the conference.

For the sake of example, computer music is narrowly defined here as being computer generated and intended for reproduction rather than performance. Characteristics include the abandonment of tonality and acoustic instruments as the basis for musical language. The emphasis is on timbral transformation and microtonal textures (Smalley 1997).

Recent work (Whalley 1999a&b) has dealt with applying system dynamics modelling to structure in computer music. This work is first summarised to provide a background to the topic. Milicevic (1998) argues that the ideal reception of music is neither structural nor metaphorical, but lies in the dialectic between the two. The model presented here (see figure 1) extends my recent work by reflecting this view.

System dynamics thinking involves the application of non-linear models to simulate complex narratives (see Forrester 1961). The techniques have been popularised through commercial modelling packages such as Vensim, Powersim, and Stella. Simulation is based on influence diagrams, stocks, flows, and feedback loops. The application to music is limited to date.

System dynamics models rely on a three step process: drawing the structure of the narrative or situation being examined; making assumptions about the nature of the relationships between parts of the structure; and running the model in compressed time to illustrate the interaction of various parts. These tools can check assumptions about the situation being studied and run ‘what if’ scenarios to test different approaches to problems. As such, they provide a means to understand the dynamic experience of computer music.

In the structure/relationship model (figure 1) built using Stella software, the double lines with an arrow represent the direction of flows of information (like verbs). A box is an amount or stock of something (like a noun). The single arrow lines illustrate feed back or influence connections. The ‘clouds’ indicate zero activity. Relationships between parts are influenced by adding either graphs or formulas into the circles in the diagram to reflect assumptions made. The narrative is then simulated in any timeframe. Output is graphed based on any part of the model selected. This process allows the user to trial several strategies by altering the driving formulas.

The link between system dynamics modelling/simulation and computer music structure is that music is a time based art form grounded in the experiential flow of events and relationships similar to other narrative art forms such as plays. Like other narrative art forms, it has a dynamic shape of interest.

A dynamic shape of interest in most classical and popular drama, large-scale western art music, and popular song has a main climax about two-thirds to three-quarters the way through the piece. This is played out within the framework of introduction, complication, climax and resolution; or musically, introduction, variation, contrast or development, and recapitulation.

Abstract music as narrative does not achieve this dynamic interest through verbal/visual discourse, but through aural/physical discourse. Both approaches are kinetic but differ in that stories deal with the explicit and 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. This provides the link to emotional modelling discussed later.

The control of the structural dynamic of a musical work based on the manipulation of unity and variety of thematic material is a cornerstone of the development of conventional composition technique in music. Without a systematic and explicit way of illustrating this in real-time, acquiring this skill in computer music is usually by trial and error. This is not helped by the structural dynamic of computer music often being self-referencing rather than to an external referent such as tonality. This is why a modelling process based on listening in computer music holds significant possibilities.

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 to can vary widely, regardless of attention.
The model here (figure 1) is based on the composer's perception of how they would hear the work. In part it maps the dynamic shape of interest (right hand side) based on unity/variety input and manipulation (left hand side) as an abstract of the music. The model is based on certain assumptions. First, that music as dynamic structure is a representation of personal experience of time (Imberty 1993); second, that this experience is only knowable through the perception of sound events (Kramer 1988); and finally that the modelling of these events interactively in real-time will approximate the experience.

In the outputs of the model (from TotU&V meaning the total of unity and variety on figure 1) change is based on Pressings notion (1994) that there are two main types of change. Rearrangement change occurs when time is expressed through motion or changes of position in unchanging sound objects. For example, through notes or recurring sound complexes. Attribute change occurs when time is expressed through alterations in the attributes of sound objects, such as parametric alterations in the qualities of a sound.

The dynamic shape of interest is the end for the structural aspect of the flow of events in the model, and the assumption is a perfect correlation between this and the contour of tension and relaxation in the piece.

Since this is a tool for composition, a limitation is assuming that all listeners will be as fully cognisant and musically attentive and as informed as the composer. This is assumption many composers have made historically, although they may arrive at this situation by repeated listening to a work.

Entering and abstract of the music into the model relies on composers being able to auralise individual elements of the composition in the first instance as they would do traditionally, or enter them in when a composition is completed. This is done by entering information into the thematic drivers of the model (inputs to TotU&V on figure 1). Each thematic event is mapped graphically as contributing to unity or variety throughout the piece at set periods. The graphs are drawn so that each timeframe is decided based on what musical information proceeded it: whether information is the same or different to what has happened before, and to what degree. Inputs to stocks
(anger etc.) indicate a contribution to unity and outputs to unity. Zero allows no contribution either way.

To this point, the approach relies on composers taking a thematic approach to generating computer music, yet makes no assumptions about what themes may be made up of in terms of auditory material, or how they may relate to each other. The thematic inputs to the model in figure 1 and the relationship between inputs is but one example of a range of possibilities, provided only for the sake of illustrating the idea.

Historically, the main drivers of tension and relaxation in western narrative art forms was the juxtaposition of opposites, such as characters or situations. In tonal music this tradition continues through musical thematic material built on key variations of tonic, dominant and subdominant poles (Whalley 1999b). An example will quickly illustrate this connection through system dynamics modelling.

In figure, the three stocks and the relationship between them that provide the input to TotU&A are based on a model that maps the psychological accumulations in Hamlet’s character (Hopkin 1992). Simply substitute ‘Disgust’ with ‘Willingness to Act’, ‘Sadness’ with ‘Level of Melancholy’, and Anger with ‘Passion for Revenge’. As a model, the archetype can be applied to any number of narrative situations, such as tonal music. Relating this to conventional key contrasts (modulation schemes) in a major key, a parallel based on the above diagram would be to substitute ‘Willingness to Act’ for ‘Need for Tonic Key Activity’, ‘Level of Melancholy’ for ‘Need for Related Key Activity’, and ‘Passion for Revenge’ for ‘Dominant Key Activity’. The input/output flows from the stocks (boxes) would and increase/decrease in each of these activities. In these terms, the significance of the diagram to tonal music is providing a variation on a structural view of classical music’s sonata form.

Of course, each computer music composition may have its own unique structure, themes, and set of variations in internal dialectic according to the assumptions made about the relationship between parts. Again, the model presented here is an example only.

Without tonality as an external theoretical referent, and an explicit scheme that can be related through words or pictures, computer music runs the risk of becoming increasingly dislocated from the western dramatic tradition. The manipulation of sound objects becomes a primarily intellectual art, in contrast to an emotional/kinetic one built on common wider audience experience of everyday dramatic narratives.

The manipulation of sound objects that share common metaphors with wider audiences is often the aspect computer music that actively engages non initiates in the experience (Bridger 1993). In these terms, most non-academic audiences ‘read’ this music not technically but in semiotic terms. In contrast, a composition may have an interesting structural dynamic but if the composer has no control of semiotic discourse, be a maze of semiotic confusion. Using thematic juxtaposition as a narrative structure based on a clear semiotic scheme that is common to a general audience then holds the promise of computer music finding a wider audience.

The key to mapping in general semiotic intention/response into the model here, or the coding of emotion through the manipulation of musical thematic unity and variety, lies in film music theory (Gorbman 1974). The outcome is illustrated in the work of many experimental film music composers. The difference between writing for film and using system dynamics modelling as a basis to generate scores, is that the composer writes the structure of the narrative and controls the dynamic shape. This approach allows creativity within a broadly agreed framework of semiotic meaning. The question is ‘how’ in theoretical terms.

The translation of the explicit to the musical/implicit is part of the trade of film music composition (Hagen 1972:156&166). Gorbman (1974) argues that film music functions in context by ascribing meaning by mutual implication: the music helping interpret the film and visa versa. Music in film is a signifier of emotion (Gorbman 1974:71) or a signifier of the intuitive by expanding on the explicit nature of the visual information allowing an audience to make a personal connection to a film. This connection is only possible through collectively shared musical codes. Film music may be written to elicit private emotional responses and denote personal feelings, but the music also reveals collective feelings as audience (Frith 1998:136).

Gorbman (1974) notes that cinematic musical codes, the musical encoding of emotional response for cinema, are created through being used in various guises connected with visual scenarios. i.e. there are patterns that are variations on basic cinematic archetypes that are given individual expression by composers. Yet to be effective and make sense, cinematic codes must also rely on cultural musical codes that are prevalent outside cinema in the wider community.

What a particular piece of music ‘means’ in implicit terms is constantly defined by the ways that it is mediated by being embedded in a larger set of extra musical associations. We have musical symbols for a sense of foreboding and evil for example. We also connect musical codes to wider cultural ways of viewing and experiencing life. Death in western culture is usually understood as a solemn and sad time, and funeral marches tend to be written at slow speeds using low registers.

Similarly, cultural musical coding involves paralleling musical elements with extra-musical concepts. For example, instrumental colour is understood in terms the physical colour spectrum being dark or light; pitch is considered in terms of physical position as in being high or low; and musical textures in terms of tactile qualities of being thick or thin, or rough or smooth (Meyer 1956).
The idea of composers' encoding their own 'take' on emotional/intention/response is the well established, and usually drawn from experience that is common to wide audiences.

For the sake of illustration, the model in figure 1 is driven by three of the main emotions based on part of Descartes' (1647) taxonomy of primary emotions: anger, sorrow, and disgust. The model can also cope with surprise, since this can be added into any part of the variety experience: AV on the diagram for example. In this model, the narrative structure of Hamlet's personality and his dilemma is used as the basis for the composition. This approach illustrates how different composers could use the same model to come up with different interpretations of the structure/dynamics of the piece by changing the underlying assumptions about influences between parts, and adding individual musically encoding of the emotions given.

System dynamics modelling then allows composers to map any narrative situation using the tools and the approach given here. It should be noted however that this is 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, when one has some basic ideas. A limitation of the approach presented here is artistic. 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 or message. To use an analogy from literature, there are many literary critics with a good understanding of structure but who are unable to write an engaging novel. Musical craft is one thing; original ideas are sometimes another.

CONCLUSION

This paper stems from a concern about what appears to be a diminishing sense of dramatic art in current computer music due to a lack of wider audience engagement based on commonly shared musical coding of emotion and dramatic narrative archetypes. The approach outlined presents a way of addressing this.

The counter argument to the assumptions made here is that musical structure is a reflection and part of the philosophical paradigm that underpins an historical world-view and that one approach is simply different rather more artistically significant than another. This argument is often used in support of much algorithmic composition being process rather than goal focused (Chadabe 1996). However, for the most part, artistic outcomes based on this approach often have a very limited audience outside the academy. Perhaps a significant reason is that most people’s listening experiences of music in the West are grounded in the narrative tradition of thematic juxtaposition and variations of classic dynamic shape.

The narrative archetypes of dramatic art also reoccur in many situations in daily life and can be made explicit though system dynamics modelling (see Senge 1992), presenting possibilities for composition generation. Perhaps they are the memes that Dawkins (1976) put forward: patterns that replicate culturally over many generations because of their relevance and usefulness, and there integral connection to human experience.

Far from arriving at a conservative solution, system dynamics modelling of dynamic shape and thematic juxtaposition based on shared kinetic/emotional musical archetypes then allows composers to create within a gambit known by a wider listening audience, yet allow individual experimentalism.

The approach also makes an historical understanding of narrative arts central to music making. Using system dynamics models of narrative artistic structures that have been historically successful as a basis for current computer music compositions then allows for the wisdom of the past to be combined with current practice.

REFERENCES


