Composing with microsound: an approach to structure and form when composing for acoustic instruments with electronics

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Abstract

This paper explores the implications of using microsound as an organising principle when structuring composition for acoustic instruments and electronics. The ideas are presented in the context of a composition by the author for bass clarinet, flute, piano and electronics: The Sea Turns Sand To Stone *(2015) (Winner of the William Mathias composition prize, Bangor New Music Festival 2015). After giving a definition of microsound, the compositional affordances of microsound are considered. Microsound is presented as an aesthetically rich tool for creating cohesion between acoustic and electroacoustic sounds and different parameters for manipulating the sounds are presented. Issues of structure and form are discussed and the challenges of creating a coherent environment that uses both note-based and texture-based material are explored. The implications of applying different models of form to mixed compositions are considered. This leads to a discussion of the different relationships that exist between the acoustic and the electroacoustic parts of a composition. Extended instrumental techniques provide one way of creating perceptual links between the acoustic and the electroacoustic. Examples of the way such techniques have been used in conjunction with microsound to impose a structural framework on* The Sea Turns Sand To Stone *are given. Finally, the use of a pure sound/noise axis, mediated through the application of microsound, is presented as a viable organising principle for structuring mixed compositions. The implications of such a model are explored and the underlying structure of* The Sea Turns Sand To Stone *is presented as a practical example of the application of the process.*

1. Introduction

The Sea Turns Sand To Stone (2015) is a composition by the author for bass clarinet, flute, piano and electronics, in which the electronic part is generated using an software environment for granular synthesis which manipulates sounds from the acoustic instruments. The output of the granular synthesiser is itself further manipulated by four different effects processors. A principal aim of the composition is to explore issues of structure and form in music for acoustic instruments and electronics. These are focused on the following research questions: firstly, how can microsound be used as part of an organising principle in order to provide an aesthetically satisfactory sense of cohesion between the acoustic and the electroacoustic elements? Secondly: how can microsound be used to develop and control both small-scale and large-scale structural and formal relationships between different aspects of the composition? Before these questions can be addressed, however, it is first necessary to consider the compositional affordances of microsound more generally as well as the implications of using microsound in the context of acoustic instruments.

2. A definition of microsound

In this paper the term "microsound" is used to refer to an approach to composition that makes creative use of granular synthesis and other FFT based windowing techniques. Thompson defines microsound as "…more than a technique, microsound is an approach to composition which places emphasis on extremely brief time scales as well as an integration of this micro-time level with the time levels of sound gestures, sections, movements and whole pieces" [1]. This is broadly the definition that will be followed in this paper. Complex evolving sound spectra are constructed out of streams or clouds of sonic particles of very small durations, typically 100ms or less, although grain sizes larger than 100ms are also possible. Larger grain sizes preserve more of the acoustic spectra of the source material while shorter grain sizes tend towards wide band impulses of noise. Larger grain sizes can be combined with shorter grains to produce a wide variety of sonic possibilities and relationships to the original material. These new spectra can then be further manipulated with other electronic processes to create an elaborate network of different relationships with the source material.

3. The compositional affordances of microsound

Following on from the definition given above, microsound can be considered as more of an approach to composition than as a genre or a single technique. The emphasis is always on composing with sonic material built on a variety of time levels. Implicit in any composition which uses microsound as the primary structuring principle is an approach to time that permits the coexistence of sounds as they unfold on different time scales. Micro-events are built into gestures and textures that are then further developed into longer phrases, sections and entire compositions. In this context, definitions of gesture and texture broadly follow Smalley's definitions, where a gesture implies some form of energy-motion trajectory, spectral and morphological change, linearity and narrative and a texture is a sound which evolves, if it evolves at all, on a more worldly or environmental scale and where internal activity is more important than forward impetus [2]. Gestures and textures exist along a continuum and it is not always clear where the distinction is to be drawn between them. These micro-events can co-exist and contrast with sounds derived from other sources such as note based events from acoustic instruments, synthesised sounds, concrète sounds from field recordings or other sound objects. These sounds can themselves be further broken down into micro-events, transformed and re-contextualised. Microsound is therefore a powerful tool for juxtaposing the recognisable with the unrecognisable or to create a continuum from the possible to the impossible. Sounds can be divorced from their usual contexts and reframed with transformed versions of themselves.

Because of the nature of the process, environments for generating and manipulating microsound output a very large number of sonic events and this can lead to potentially very complex control networks. The granular synthesis environment used for the *Sea Turns Sand To Stone*, for example, consists of three independent 16-voice granular synthesisers. If all three granular synthesisers function with a grain size of 10ms, then (ignoring any limitations imposed by the signal vector size or the input/output buffer of the software environment) the resulting output would consist of 4800 grains per second. Through careful mapping of the user interface to the sound-producing engine of the software, however, the manipulation of a relatively small number of parameters can produce a huge variety of different sonic possibilities. The principal parameters which have been used for *The Sea Turns Sand To Stone* are:

- Grain size – the length of a single sonic particle
- Grain density – the number of grains per second

- Playback speed – the speed at which the software reads through the granulated soundfile to produce time stretching of time compressing effects. Playback speed can also be reversed or set to zero in order to “freeze” the sound
- Jitter – a variable offset of the onset time of each grain which can be manipulated to make playback of the source material progressively less linear
- Number of voices – number of simultaneous grain streams produced by a single granular synthesiser. These streams may be simultaneous or they may overlapping depending on settings for jitter
- Number of channels – the number of independent environments for granular synthesis happening at one time. The majority of the compositions in this commentary use an environment with three granular synthesisers. This was felt to be an acceptable compromise between compositional affordances and limitations imposed by computer processing power. Each environment may use the same source material or the source material may be different to produce a variety of results.
- Relative balance of channels – controlling the relative amplitudes of the three different environments can have a significant effect on the output as contrasting spectra fade in and out.
- Post granular processing – the way in which the output of the granular synthesiser is processed, if it is processed at all, will of course have a considerable influence on the resulting sonic spectra and its relationship to the source material. It is important, therefore, that there are good aesthetic reasons for including any post granular processing and that these are sympathetic to the overall aesthetics of the composition.

The choice of window function also has an audible effect on the output but although the software environment includes an option to change the window function, this has generally been left as a fixed value. The cosine function was the least likely to introduce unwanted artefacts into the sound and so this was chosen as the default envelope.

Most of the parameters described above can be set to static values, or they can be interpolated between different values. How these parameters have been mapped to the audio engine of the environment, and how they have been made available to the composer or the performer, will have a significant impact on both the compositional process and the performance.

Through careful manipulation of the above parameters, the environment for granular synthesis is capable of producing an enormous variety of rich and evolving sonic landscapes. Progressive application of the parameters can result in the source material appearing in the output as an electronic facsimile of the original acoustic input at one end of a continuum, and as wholly new material with little or no perceptual relationship to the original at the other end. Along this continuum, different aspects of the source material can be revealed or hidden in the output. The original material can be dramatically slowed down in order to reveal previously hidden detail, for example. Or the overall gestural shape of a sound can be preserved while dramatically changing its spectral content. Gestural sounds can quickly transform into textural sounds and back again. Sounds can appear to “dissolve” through careful manipulation of grain density.

Juxtaposing the output of the granular environment with the original acoustic material is a musically rich and aesthetically cohesive approach to composition. Microsound is, however, essentially a texture-based approach and as such typically does not conform to the aesthetics, traditions and performance practices of note-based music. Nevertheless, microsound can be used as a compositional device which extends and compliments the output of the acoustic instruments.

Microsound is a particularly powerful technique for playing with source identity and context as it can act as a bridge between the real and the surreal, or sounds which are perceived to be physically possible and sounds which are perceived to be physically impossible. When combined with other electronic techniques it becomes a very fluid environment for re-contextualising sonic events. Beyond its classic use as an "acoustic microscope", microsound is also a very effective means of exploring tensions and contradictions as sounds transform from the real to the imaginary, again in the sense of perceived physical possibility and impossibility. Ambiguities and contradictions arise as gestures become textures and causal relationships break down. Connections are broken and sound objects are repositioned in new contexts.

It is a contention of this paper that microsound can be used as an effective organising principle when combined with acoustic instruments in mixed compositions. Microsound can function as a bridge between very different traditions of electroacoustic and acoustic music. The seemingly contradictory traditions and performance practices of post serial, pitch-based writing for acoustic instruments can be productively combined with a texture-led electroacoustic approach using microsound as a unifying factor.

4. Different models of structure and form

Before we can consider the ways in which microsound can be used as an organising principle to create a cohesion between the acoustic and the electroacoustic, it is first necessary to outline the issues raised when considering the problem of form in music, particularly in the context of mixed acoustic and electroacoustic music. It will then be possible to explore how microsound can be used to develop and control both small-scale and large-scale structural and formal relationships between different aspects of the composition.

When discussing form it is important to draw a distinction between form as a concept and the various manifestations of that concept, such as sonata form, binary form etc., which have emerged historically through the analysis of different compositional practices. One definition of form as a concept is that it is the "…constructive or organising element in music" [3]. Another way of stating this could be that form is the way in which the smaller microstructural elements of a composition are grouped together to create an overall macrostructure. The distinction becomes problematic, however, when we consider the criteria a composer may be using, explicitly or implicitly, when ordering the material of a composition.

A composer may be choosing from perhaps three different approaches when imposing form on compositional material: a top-down schema led model, a bottom-up material led model and a generative or process-led model. Within those broad categories there exists the possibility of a great number of different approaches that combine ideas from each area as appropriate to a particular circumstance. The aesthetic reasons for choosing one particular approach to form over another are not always clear, however, and may be influenced by issues of genre conformity or historical precedent in ways which may not always be sympathetic to the compositional material.

Justifying compositional choices becomes even more complicated when we consider that form is not usually an isolated aspect of the composition but has an intimate relationship to the material of the composition (there may be exceptions to this: John Cage's *Imaginary Landscape No 5* is one of many examples of a composition where it could be argued that the form is imposed on the work in a highly prescriptive manner by the composer but the content, the musical material which inhabits the form, is left to what are essentially aleatoric processes). This becomes even more problematic when we consider that there is often a somewhat circular

relationship between generalisations about form and the application of formal models by composers. Formal templates and approaches to form are extracted from compositions identified as typical or exemplary in some way and these models are then often used as examples of best practice and followed by other composers. Di Scipio [4], [5], Collins [1] and Whittall [3] provide further discussion of these ideas.

Any act of composition can also be viewed as an actualisation of a *theory* of form, even if that theory is not explicitly stated, and even if the composer is not aware of the formal implications of his or her choices. In a top-down approach composers may adopt formal templates for their compositions, which may be adaptations of existing templates or may be novel templates specific to that composer or composition. Di Scipio [4] makes the point that in a top-down approach, the form of a composition pre-exists the composition, independent of the material of the composition, not only in the mind of the composer but also in the minds of the listeners as well. The composition exists as an externally conditioned idea which must be recreated in a new context. For Di Scipio the form of the composition represents a mental *solution space* which *affords* certain actions. Di Scipio develops this idea further by stating that the composer can choose not only from the range of afforded actions but also from suggested extensions to what is explicitly afforded by the solution space. In the context of this idea, it is interesting to note that the history of the development of music technology, and by extension the history of electronic music, contains countless examples of this feedback loop where artists use technology in ways not immediately suggested by the affordances of the process or environment, and this leads to technical innovations which themselves suggest new unforeseen affordances. The history of the development of form is also driven by similar feedback loops where existing solution spaces suggest new affordances which themselves become established practices.

In a bottom-up approach to composition, composers may allow the small-scale structural elements of a composition to dictate the macrostructures. In such cases a composer may use very strong rules or clearly defined criteria which govern the development of the material. There may be a very strong crossover with, or the process may be identical to, process or rule-based composition. In generative or process music, the form is governed by the underlying processes embedded into an associated compositional system. In its purest form, once the rules of the system have been established, the compositional processes then dictate the nature of the material as well as the form of the overall composition, often with little or no further intervention from the composer – the material is accepted as the inevitable outcome of the process. The act of composition may also become an act of curation, where the composer selects phrase level or larger scale material output by the process in order to assemble the final work.

It is not always so clear, however, what criteria a composer may be using when selecting material for a composition. If the underlying criteria which determine the choice of compositional material are not explicitly recognised by the composer during the production of a composition, then it follows that they are also unknown to the listener during the reception of a composition. Thus in an entirely rule-based process the listener may or may not be aware of the underlying processes which ultimately determine the form of the work and knowledge of such processes is rarely a prerequisite for listening. In both cases, however, both composers and listeners feel entitled to make judgements as to the degree to which a composition has been successful. As a consequence it is necessary to consider the criteria a listening community may be using to make such judgements.

Emmerson [6] proposes a model of composition which addresses the issue of what criteria composers and listeners may be using when they evaluate a work. The model is shown in figure 1. In Emmerson's model the compositional process begins with an action, the production of sonic material, which is then tested or evaluated as being suitable or unsuitable for inclusion in the composition. If the material is unsuitable then it is either rejected or modified. The modified

material then either becomes a new action or is stored in a repertoire of new actions for future use. The question, then, is what is the nature of the test used by the composer to accept or reject the material? In such cases it may seem that composers are unconsciously imposing their own aesthetic prejudices and conditioning onto the material. For Emmerson, however, it is the existence of the action repertoire that forms the basis of the test by which the sonic material is assessed. The exact nature of the test must remain elusive, (it is "unanalysable" in Emmerson's words [6] (p.143) but the important point is that the action repertoire is not the private property of the composer but that it is open to a community of interest made up of composers, performers and listeners whose views are trusted and valued and who collectively decide what kind of material may be included in the action repertoire.

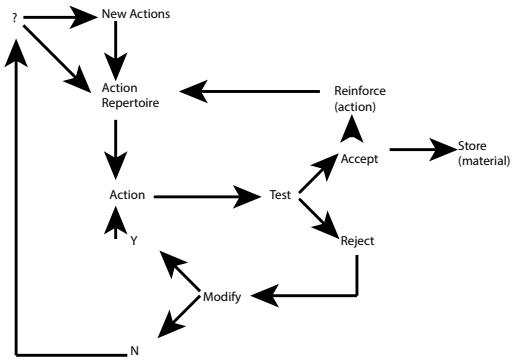

Figure 1: Emmerson's model of composition: (adapted from [6])

For Di Scipio [5] the shift from a top-down, example based approach to form to a bottom-up, rule based approach is a shift from an externally conditioned, analysis based idea of form to an idea of form based on an awareness of compositional processes. Whereas in a top down approach the form pre-exists the work, in a bottom up approach the form emerges from an explicitly designed process and manifests itself as an epiphenomenon of some underlying structure. In electroacoustic music, a natural endpoint of a bottom-up approach is that it can be the sounds themselves that are composed through the application of rules to various synthesis processes. Sound spectra cease to function as material to fill emerging structures and instead become the structuring principle behind the composition. Spectral morphologies replace an instrumental approach to composition and thus end the dualism between form and material, between container and contents (see also Emmerson [7] for a further discussion of these ideas). In mixed compositions, however, the problem then becomes how to unite a dualistic, content and material approach to form with a texture centred, morphological approach.

It is of course possible, and indeed common, to combine the three broad approaches to form outlined in the previous paragraphs – top-down schema driven, bottom-up material driven and generative, process-driven – in order to produce a complex, multifaceted set of interrelationships among the materials of a composition which result in the final form of the piece. Mixed compositions, however, typically combine two very different traditions and approaches to form. In the following section, we will consider ways in which microsound as a process, as well as the affordances of microsound, can be applied as organising principles when considering form in mixed compositions. To begin with, however, it is necessary to consider why mixed compositions are particularly problematic, as well as how the acoustic and

the electroacoustic parts relate to each other. From this it will be possible to explore ways in which microsound can be used as a process for bridging the two traditions.

5. Structure and form in context of mixed acoustic and electroacoustic compositions

A significant problem to overcome when considering issues of form specifically in relation to instrumental music with electronics is that mixed compositions combine the languages and performance practices of two often very different traditions. This is not a situation unique to mixed compositions, of course, but the issue is particularly pronounced in this case as the approaches of the different traditions often appear to contradict each other. The challenge is to find a satisfactory way to make these differences coexist.

The acoustic parts and the electroacoustic parts of a composition can relate to each other in a number of different ways. The two parts engage in a complex and shifting network of relationships in which each part may be equal, or one part may dominate the other. These relationships can also of course change during the course of the composition. Outlining these relationships can help to identify compositional strategies that can then be used to create structure and cohesion in a work. An understanding of these relationships can also be used to show how microsound can function as a compositional tool to reinforce or subvert relationships between the parts. Emmerson [8] uses case studies to explore the ways in which the acoustic relate to the electroacoustic. Some of the ways in which the acoustic part and the electroacoustic part can relate to each other are outlined below.

The acoustic part and the electroacoustic part can be in a state of conflict or coexistence. There can be transitional or morphological relationships where events can be perceived to have their origins in one sound world before moving to the other. There can be causal relationships where events in one sound world can be perceived as causing events in the other. There can be gestural/textural relationships, which can manifest themselves through framing, layering or montage. There can be mimetic relationships where musical or extra musical relationships can emerge between the different sound worlds. There are also spatial relationships between the acoustic and the electroacoustic part. We now consider some of these relationships in more detail before showing how they can influence form and be manipulated through microsound in mixed compositions.

One of the more fundamental ways in which the parts relate to each other is through spatial relationships. These relationships can be either literal, in the sense that a sound really is coming from a certain position or has been produced by a certain sounding body, or metaphorical, where a sense of space is suggested or implied through some process or psychoacoustic phenomenon. There are different categories of spatial relationships. These can be summarised as follows:

- Spatial relationships associated with movement (how is the sound perceived to be travelling in space?)
- Spatial relationships associated with position (where is the sound?)
- Spatial relationships associated with material (how big is the sounding body? What is it made of? How is it being excited? Etc.)
- Spatial relationships associated with environment (in what sort of space is the sound world unfolding? Is it a real space, an impossible space, a changing space? Etc.).

Typically, in a live performance of a mixed composition, the acoustic part will be anchored to a fixed position on a stage and the electroacoustic part will be diffused through an array of loudspeakers. Blending the two parts can be problematic, however, because of the way in which the sounds are transmitted. The electroacoustic part typically emanates from directional speakers whereas the acoustic part will be produced by instruments which radiate sounds in much more complex patterns [9].

When developing models of form for music with mixed acoustic and electroacoustic elements, it is useful to identify a principle of internal cohesion to act as an organising principle which will then unite the different sound worlds in a satisfactory manner. This is not necessarily straightforward, however, as the disciplines of acoustic and acousmatic music have complex and often contradictory relationships, particularly in the context of form and material. Di Scipio encapsulates these different approaches by making the distinction between composing *with* sound and composing sound [10]. In the first case the emphasis is on the relationships (gestural, tonal, dynamic etc.) that exist between the sounds and in the second case the emphasis is on the creation of the textures and timbres themselves and the relationships that unfold as those textures develop and interact.

In the first model, timbres are, at least to an extent, interchangeable. A phrase, for example, could be played on different instruments and still be recognisably the same. In the second model, timbre is the central focus of the composition: it is not possible to change the timbre without fundamentally changing the composition. With a great deal of crossover and a great many exceptions, acoustic instrumental music typically tends towards the first model whereas acousmatic music tends towards the second. Therein lie some interesting tensions but these potentially conflicting considerations need to be handled carefully. Models that combine both approaches, however, are only really satisfactory if there is a model of interaction, explicitly stated or implicit in the tradition, which unites the seemingly disparate electronic and acoustic parts.

6. Towards a pure sound/noise axis as a model for structuring mixed compositions

One model that has been extremely successful in the structuring of instrumental music has been that of functional tonal harmony. In this model harmonic relationships are based on hierarchies of perceived levels of stability as sounds progress through degrees of consonance and dissonance. The Finnish composer Kajia Saariaho has borrowed the ideas of consonance and dissonance from the language of tonal harmony and used them to create new models for the structuring of texture based music [11]. Saariaho's solution to the problem of combining the different sound worlds of the acoustic and the electroacoustic parts is to develop a sound/noise axis to unite the two elements. In Saariaho's model, the concepts of consonance and dissonance are replaced with concepts of pure tone and noise. This then becomes the organising principle behind some of her compositions. The axis allows her to create a logical timbral continuum which provides a pre-compositional framework where sounds can be placed on a theoretical hierarchical grid between pure sound, e.g. a periodic sound with few or no partials – a sine wave would be the ideal, and noise – complex, aperiodic spectrally dense sounds. In Saariaho's model, timbre takes the place of harmony with consonance being replaced by pure sound and dissonance being replaced by noise. Noisy, grainy textures take on the function of dissonance while smooth, fluid textures assume the role of consonance. The terms sensory consonance and sensory dissonance can be used to differentiate the use of the terms from their use in the context of tonal harmony.

O'Callaghan and Eigenfeldt provide a detailed examination of two of Saariaho's compositions for acoustic instruments and electronics which use this approach, namely *Verblendungen* (1984) and *Lichtbogen* (1986) [12]. Although the two pieces demonstrate different control strategies for the electronic part, *Verblendungen* uses a tape part whereas *Lichtbogen* uses live electronics featuring the processed sounds of the live instruments, they both use the same approach to sound in order to develop a structure. O'Callaghan and Eigenfeldt [12] also propose a gesture focused analysis of the compositions. Their analysis reaffirms Sarriaho's own writings, where she discusses the use of extended instrumental techniques to create a continuum between noise and pure tone [11].

In the acoustic parts of *Verblendungen* and *Lichtbogen*, it is the spectral quality of the instrumental gestures used in the compositions that give form to the music. Extensive use is made of extended instrumental techniques in order to shift the gestures along the sound/noise axis. For O'Callaghan and Eigenfeldt gesture is defined as any perceptual unit or sound shape which develops over time. The use of the term to refer to a physical action that causes a sound is ignored. This is the definition that will be followed here. The variation of parameters over time can be thought of as giving "shape" to a sound and hence instigating a gesture [12].

Saariaho's model can be easily adapted to compositions involving microsound. Indeed, granular synthesis functions as an excellent tool for shifting textures in both directions along a continuum from pure sound to noise. The composition *The Sea Turns Sand to Stone* uses Saariaho's model as the principal underlying framework upon which structure is developed. A significant difference, however, is that in the electroacoustic part, it is microsound that has been used to create the hierarchies of timbres from pure sound to noise. Saariaho's original hierarchy has also been extended to include other conceptual polarities that can exist along a continuum between consonance and dissonance (in the context of this discussion the terms consonance and dissonance are not used in their strict, tonal sense, but rather as terms which suggest states of stability and instability). These concepts are shown in figure 2.

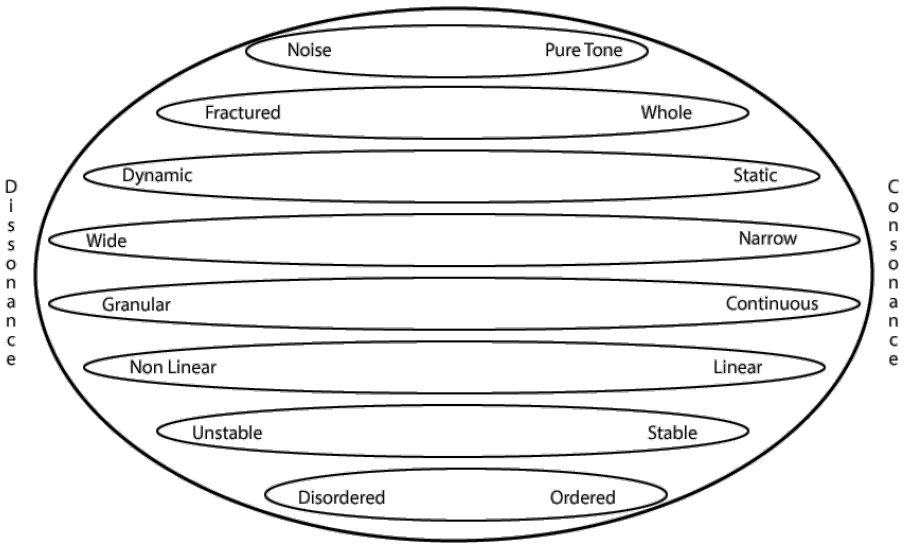

Figure 2: Conceptual continuities between sensory dissonance and consonance (Source: author's own)

Using these concepts as a guide, a schematic is created in which the acoustic part moves from a state of sensory dissonance towards a state of consonance, while the electronic part simultaneously moves in the opposite direction. The schematic is divided into seven sections. In each section, the ratio between consonant material and dissonant material shifts until the last section, where the balance is effectively reversed. The overall length of the composition is set provisionally at 7'35" and 9 seconds is taken as a basic unit of time. The lengths of the different sections, as well as the relationships between sensory consonance and sensory dissonance are shown in table 1. It is worth noting that the timings function as a compositional aid and they are not intended to be strictly adhered to during the performance. The actual length of the composition will vary from performance to performance, because the electroacoustic part is created in real time and triggered using cues in the software environment written into the score. The performers are free, therefore, to react in a more natural way than if they were playing with fixed soundfiles.

Length of section	Ninth of section	Ratio Dissonance:Consonance	Ratio (secs)
36"	4	8:1	32:4
45"	5	7:2	35:10
54"	6	6:3	36:18
63"	7	5:4	35:28
72"	8	4:5	32:40
81"	9	3:6	27:54
90"	10	2:7	20:70

Table 1: Temporal relationships between different sections in The Sea Turns Sand to Stone

A schematic showing how these relationships apply to the overall structure of the composition is shown in figure 3.

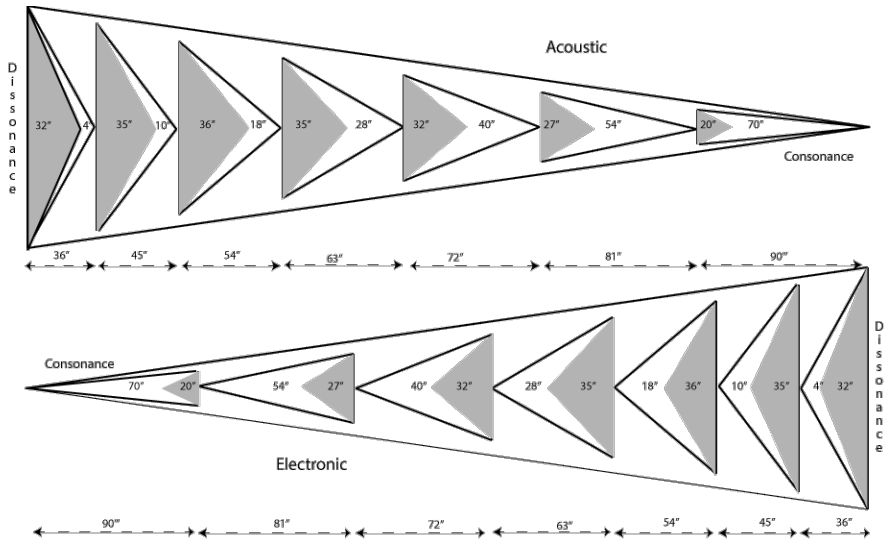

Figure 3: A Schematic for The Sea Turns Sand to Stone showing morphologies between sensory consonance and dissonance. Microstructure is reflected in the macrostructure

7. The use of extended techniques to create perceptual continua between sensory "consonance" and "dissonance"

For the acoustic part of the composition, a hierarchy of gestures has been created for each of the three instruments, starting with sounds that are perceived to be consonant and continuing through sounds that become increasingly perceived as dissonant. Following Saariaho's model, extended instrumental techniques are used extensively in the composition in order to create a suitable range of gestures.

The hierarchy of gestures used by the bass clarinet in the composition are shown in table 2.

Low register
Senza Vibrato
Ord.
Molto Vibrato
Trills
Tremolo
High register
Slap tongue
Multiphonics
Tremolo between two multiphonics
Half embouchure
Morphing between air notes and half embouchure
Flutter tongue
Unpitched air notes

Table 2: Gestures used by the bass clarinet in The Sea Turns Sand to Stone ordered from sensory consonance to dissonance

These instrumental gestures are then recorded as sound files and used as the basis for the electronic transformations. Examples of the gestures used by the bass clarinet are shown from figures 4 to 10 below.

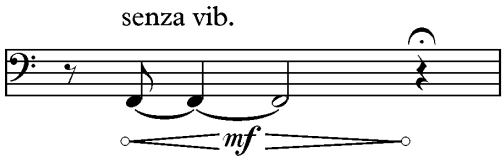

Figure 4: Bass clarinet F2 senza vibrato (Cue 1)

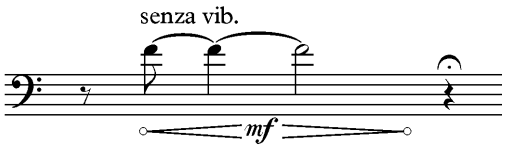

Figure 5: Bass Clarinet F2 senza vibrato (Cue 4)

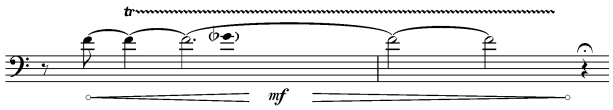

Figure 6: Trill (Cue 7)

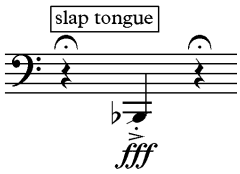

Figure 7: Bass clarinet slap tongue (Cue 10)

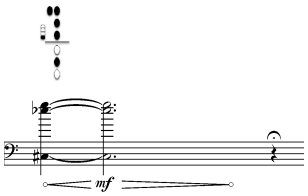

Figure 8: Bass clarinet multiphonic (Cue 13)

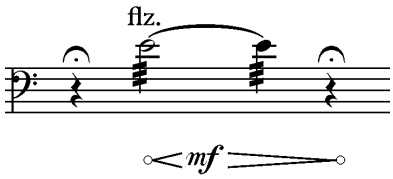

Figure 9: Bass Clarinet high flutter tongue (Cue 16)

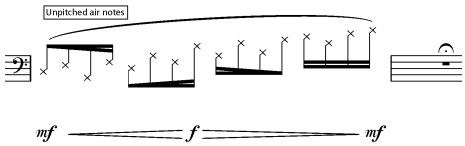

Figure 10: Bass Clarinet unpitched air notes (Cue 19)

Similar hierarchies of gestures are created for the piano and the flute. Table 3 shows the gestures used by the piano ordered from sensory consonance to dissonance.

Piano chord
Piano iterative gesture
Piano pushing agitated gesture
Piano low E flat 7th harmonic
Piano harmonic then scraping gesture
Piano scraping gesture then harmonic
Piano slide bouncing off strings

Table 3: Gestures used by the piano ordered from pure sound to noise

Examples of the piano gestures used in the composition are shown in figures 11 to 17.

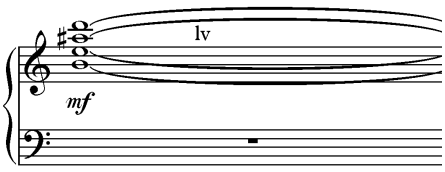

Figure 11: Piano chord

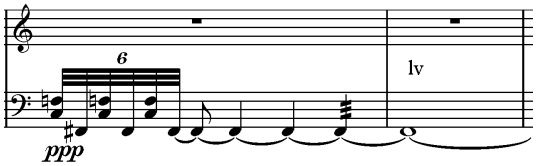

Figure 12: Piano iterative gesture 1

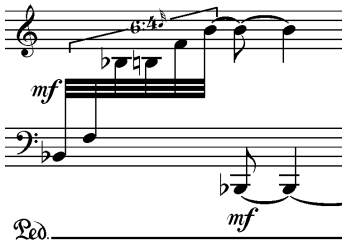

Figure 13: Piano pushing agitated gesture

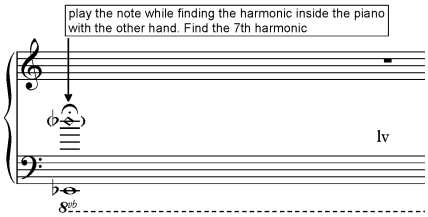

Figure 14: Piano harmonic

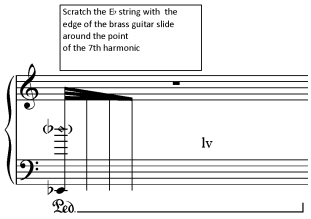

Figure 15: Piano harmonic and scraping gesture

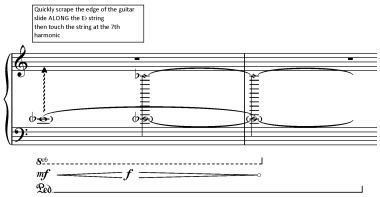

Figure 16: Piano scraping gesture then harmonic

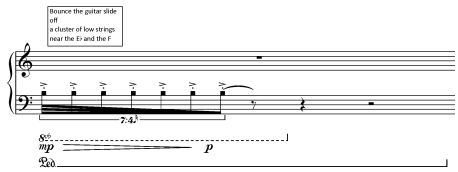

Figure 17: Piano slide bouncing off strings

Table 4 shows the gestures used by the flute in the composition.

Flute F4 senza vib
Flute F# 6 harmonic
Flute whistle tone F#6
Flute timbral trill
Flute tongue ram
Flute F#6 flutter tongue
Flute jet whistle

Table 4: Gestures used by the flute ordered from pure sound to noise

Examples of the flute gestures used in the composition are shown in figures 18 to 28.

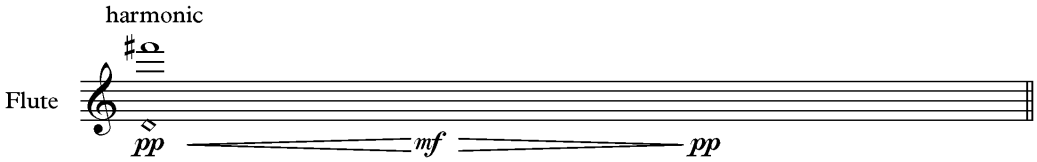

Figure 18: Flute F#6 harmonic (cue 6)

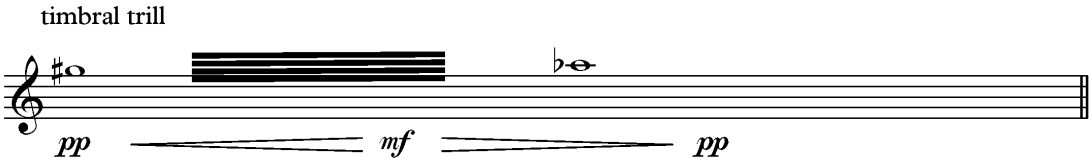

Figure 19: Flute timbral trill (cue 12)

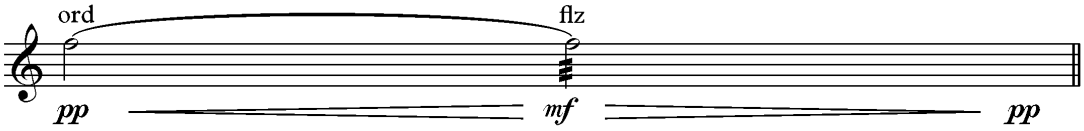

Figure 20: Flute ord to flz (cue 9)

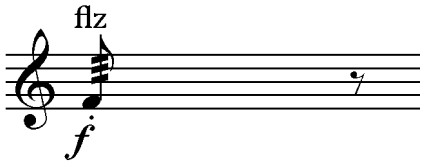

Figure 21: Flute short staccato flutter tongue

Figure 22: Flute senza vibrato (Cue 3)

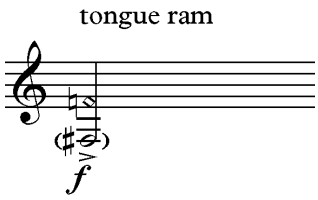

Figure 23: Flute tongue ram (cue 15)

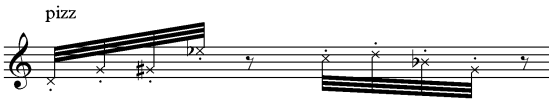

Figure 24: Flute pizz

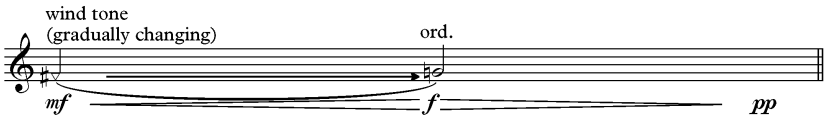

Figure 25: Flute wind tone to ord.

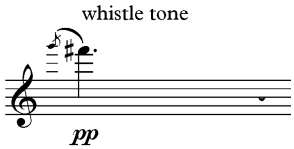

Figure 26: Flute whistle tone (Cue 9)

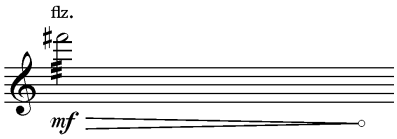

Figure 27: Flute high flutter tongue (Cue 18)

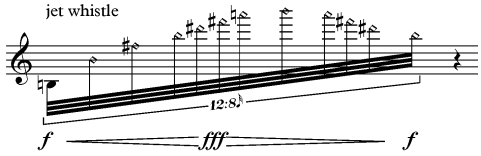

Figure 28: Flute jet whistle (cue 21)

The harmonic language used in *The Sea Turns Sand to Stone* emerges directly form the choice of material used for the gestural hierarchies.

8. Mapping affordances from the microsound environment onto the sensory consonance/dissonance axis

Having established a hierarchy of gestures for the instruments in the acoustic part, the next step in the compositional process is to map electronic affordances in the performance environment onto the sensory consonance/dissonance axis. A broad overview of the environment for the electronic part is shown in figure 29.

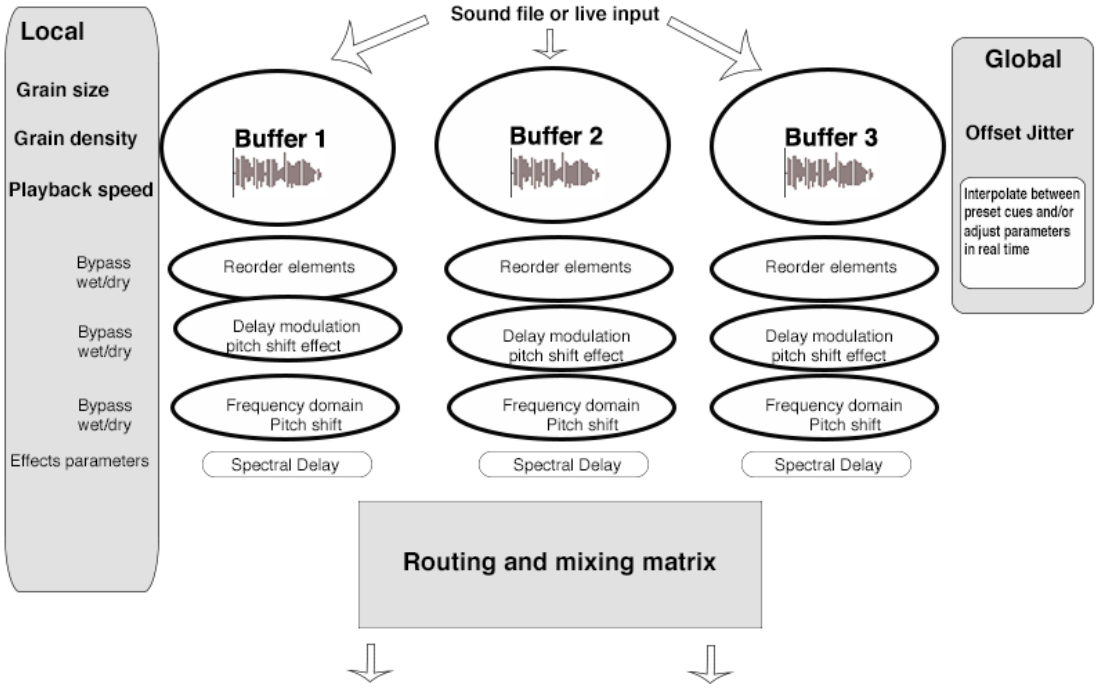

Figure 29: Overview of the electronic performance environment

The schematic in figure 29 shows three identical channels, each starting with an independent 16-voice granular synthesiser. The output of each granular synthesiser then flows through four different processors. The first process allows the elements in the output of the granular synthesiser to be reordered. The second is a delay-based pitch shifting effect which can be used to introduce comb filtering and amplitude modulation artefacts into the sound. The third is an FFT based pitch shifter. The final effect in the chain is a spectral delay, which can be used either to give a sense of the sound inhabiting an acoustic environment, or to emphasise and freeze certain frequencies in the spectrum of the sound. All of the processes after the granular synthesiser have balance controls so that the ratio of the processed to the unprocessed sounds can be adjusted.

Clearly, the performance environment for the electronics has a very large number of parameters. In the context of this composition it would be inappropriate to expect a performer of the electronic part to be able to control the electronics in any meaningful way without significantly redesigning the interface. Indeed, the large number of user adjustable parameters could even be seen as a restriction on creativity. This is because constraints in interface design are as important as affordances. Creativity is often a result of what is not possible rather than what is possible. For this composition it would be more appropriate to allow a higher level control of the parameters, where chains of events can be triggered globally by sending out multiple messages to trigger complex, carefully designed events. In this way, the benefits of having the flexibility afforded by many user-adjustable parameters can be utilised without the disadvantages of an overwhelmingly complicated environment.

Having three separate 16-voice granular synthesisers, each with its own independent effects routing, opens up many creative possibilities. For *The Sea Turns Sand To Stone* each of the three channels is assigned to one of the three acoustic instruments. Then, using the schematic in figure 3, and taking recordings of the instrumental gestures as source material, the electronic part for each of the seven sections of the composition is carefully pre-composed and mapped to cues in the Max environment. Detailed schematics of the electronic part are used to guide the compositional process. An example of one such schematic is shown in figure 30.

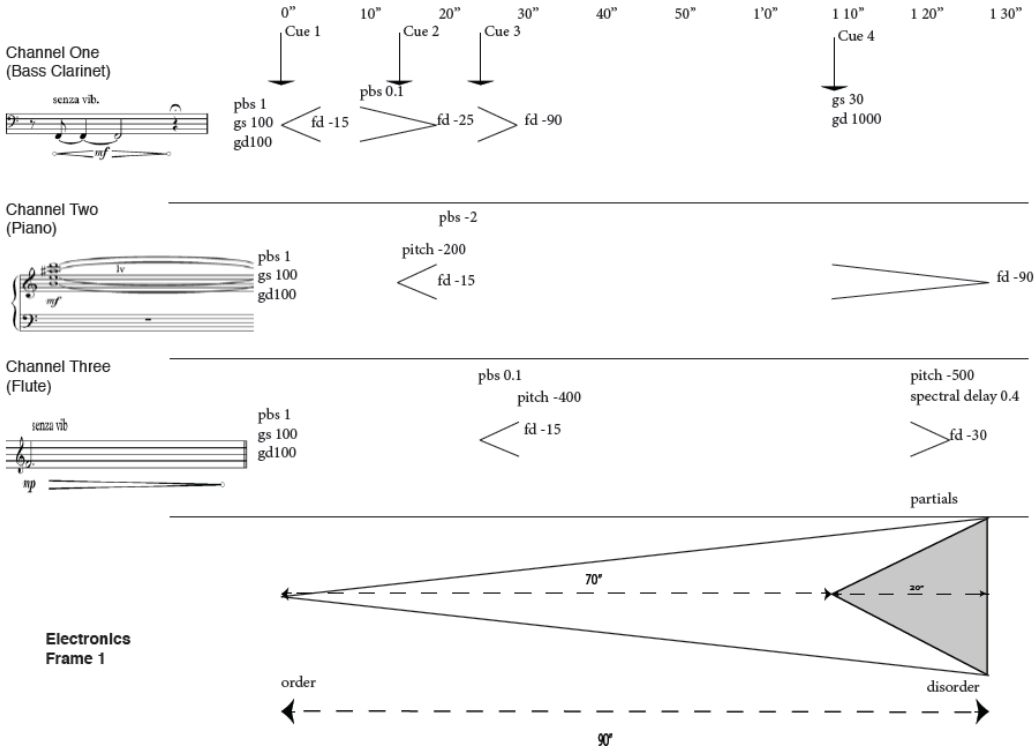

Figure 30: The Sea Turns Sand to Stone Electronics section 1

The source material for the electronic cues has been chosen so that the instrumental gestures become increasingly dissonant as the composition progresses. The electronic processing is designed in such a way as to move the sounds increasingly further away from the recognisable instrumental gestures of the source material. At the same time, the acoustic part moves from a state of sensory dissonance and instability towards a state on sensory consonance and relative

stasis. The electronic part, for example, begins with a clearly recognisable F2 played on the bass clarinet. This note is then time-stretched, beginning a gradual shift away from the source material, which continues throughout the composition.

9. Notating the electronic part

The schematics for the electronic part could be thought of as compositional scores or even, to a lesser extent, analysis scores, as they contain much of the information necessary to reproduce the electronic part of the composition. As performance scores, however, they are somewhat limited, precisely because they contain too much information and it would be difficult to incorporate them with the scores for the acoustic parts written in traditional Western notation. There are, however, issues to be considered when designing scores for acoustic instruments and electronics, particularly with regard to microsound. The solution in *The Sea Turns Sand To Stone* was to use customized graphics designed to be intuitive to understand, prescriptive and representative of the sounds produced by the electronic part. These were included on the same score as the acoustic part of the composition. An example from the score is shown in figure 31.

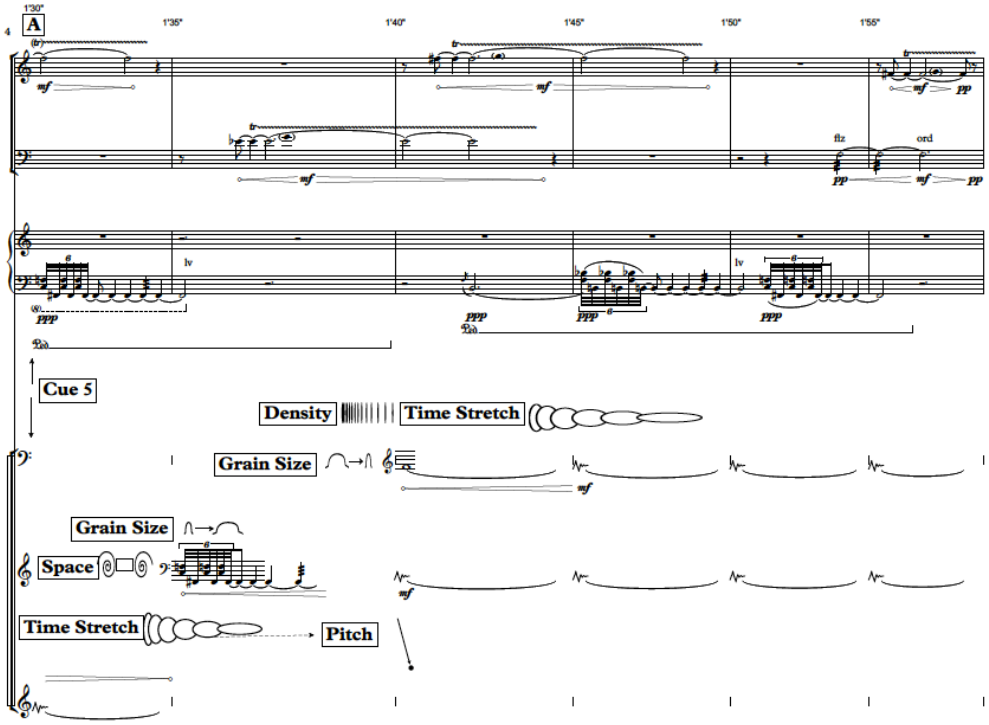

Figure 31: An extract from the score showing graphics used to notate the electronic part

10. Conclusion

This paper has considered the issues raised when using microsound as an organising principle to structure compositions for acoustic instruments with electronics. The arguments have been discussed in the context of the composition by the author: *The Sea Turns Sand To Stone* (2015). After considering the compositional affordances of microsound, the challenges of

creating a coherent composition which mixes mainly note based material from acoustic instruments with mainly texture based electroacoustic material were discussed. The application of microsound as a technique was offered as a way of creating coherence between the different elements. Different models of form were presented and the choices and strategies made by composers when structuring their work were discussed. The use of extended instrumental techniques in conjunction with microsound led to the creation of perceptual links between the acoustic and the electroacoustic. These ideas were then applied in the context of Saariaho's pure sound/noise axis. By extending Saariaho's model, and by using microsound as the mediating technique, a way of structuring the composition was found which was felt to be aesthetically satisfying and coherent. This approach also proved to be a powerful aid to composition. Finally, a system of graphical notation was devised for the electronic part that was intuitive to understand, prescriptive and representative of the sounds produced.

11. References

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