13 Trends in electroacoustic music

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The possibilities for sound manipulation, spatialisation and performance have given rise to a multidimensional approach to electroacoustic composition. Yet from whichever background we find ourselves, a number of trends following historical, sociological and technical developments can be uncovered. This chapter identifies these trends and their compositional and aesthetic circumstances, forming a springboard for a new composer to the genre. Although it is unrealistic to delve extensively into all that is relevant, I hope to encourage the reader to more deeply explore the issues raised through the references and discography. Without dwelling on the problems of terminology, let us accept for now the term 'electroacoustic music' as including all that is not purely acoustic music, based on instrumental models nor commercially orientated.

Where are we today?

The novelty of the early decades – of listening to strange sound emanating from loudspeakers – has passed. Trial and error has resulted in as many new approaches to materials and structure as has conceptualisation and intellectualisation. Yet if as composers we are to 'progress', and not 'recycle', we need to refine our art form and learn from those few works which have survived the past sixty years, as well as discover masterpieces from our current year. After all, music technology changes dramatically in less than a decade while musical aesthetics require reflection and development benefiting from longer historical periods. Too often do we hear new compositions from all environments where refinement and development in both technical approach and musical expression is stark – and would have benefited from a deeper insight into the repertoire.

In recent years, the popular versus high art divide in music has formed a topic of debate, predominantly driven by a social-economic underlay and a commonality of tools and sounds amongst diverse musical genres. As an electroacoustic composer and as a general electronic music consumer I see many music establishments – festivals, education institutions, funding bodies – attempting to collapse all electronic music genres into one enormous pool of equivalence. Although this approach is clearly useful in spreading genres across audiences it ignores two important differences:

(i) Sociological and economic differences attached to the creative process, determining the turn over of material, the importance of image and fashion in the final result and inevitably the intellectualisation and time involved.
(ii) Difference in demands on the listening process in terms of perception, cognition, the balance between emotional, intellectual and physical listening, and inevitably the duration over which listeners must actively engage and sustain the cognitive process.

Theoretically, a continuum between popular and high art genres may be possible, yet few works lie in the central part of this continuum and instead gravitate by either *poietic* (productive or formative) or *esthesic* (receptive or perceptive) constructs to each pole.

Sound for our ears: the conception of acousmatic music

The ability to record sound and compose music in a recorded format led to the most significant change in the creation, definition and perception of music. John Cage's early use of electronic means explored indeterminacy and the context of the live event, demanding a re-evaluation of the sound around us and of our definition of music. Yet the tape recorder offered much more. It allowed any sound to be used as compositional material, provided basic transformations and allowed identical replay. Most significantly, this way of working revealed new schemes for compositional organisation beginning with the sound itself. Yet in this aural compositional approach, non-aural based musical structuring might come into play at some point in the procedure.

The aesthetic differences between the *elektronische Musik* of the Cologne studio and the *musique concrète* of the Paris studio in the 1950s is well documented (Manning 1985, pp. 19–78). The former sound-world was concerned with purely electronic sources, the latter with acoustic sources of inherently complex spectra. Structurally, the former took advantage of electronics as a way to exercise precise control over the material such that detailed scores could be realised, and we can see a natural progression from the serialist techniques of the Viennese School. Stockhausen's works *Studie I & II* and Eimert's *Struktur 8* are representative examples. In contrast, musique concrète found inspiration from a rediscovery of sound via the recorded medium and an experimental aural approach. Early works from this period include Schaeffer's series of *Etudes* from 1947–8.

Musique concrète is commonly referred to as a music in which any sound can be used, but this is a misleading interpretation and I will later use the

term 'concrete sound' to refer generally to recorded acoustic sources. The original compositional method began with what was *concrete* (sound) and the process was intended to result in *abstract* music. In musique concrète we are chiefly concerned with the way sound *functions* when detached from its visual and realtime original causation or a *perceptual* method of working. It is here that the objective term 'acousmatic' can be introduced. The term *acousmatic* derives from the Akousmatikoi, a group of Pythagoras' disciples who listened to his lectures from behind a veil. French theorist Jerôme Peignot later used Pythagoras' term to describe musique concrète's separation of sound from visual reference. Schaeffer used the term for musical description to assert that a visual link between the sound source and its origin was unnecessary. Under these criteria Schaeffer established a framework for compositional practice.

In 1952 he published a syntax for musique concrète in the treatise *Esquisse d'un solfège concrète*, which appeared as the last section of the book *A la recherche d'une musique concrète*. The treatise is divided into two main sections. The first consists of twenty-five definitions to describe the *objet sonore* (a sound event isolated from its original context). The second section describes how these definitions can be applied to create a language. This *solfège* underwent substantial work as Schaeffer continued to develop his ideas, culminating in the *Traité des objets musicaux* (1966). In this substantial text Schaeffer attempts to classify all sound-producing objects by dividing their characteristics into seven parameters: mass, dynamic, melodic profile, mass profile, grain, inflection and harmonic timbre. Schaeffer further describes how he viewed the listening process as consisting of four interrelated modes – the *Quatre Ecoutes*. These modes of listening are useful in understanding the development of electroacoustic music aesthetics since Schaeffer. The Quatre Ecoutes have undergone various adaptations in both French and English. Schaeffer's originals are:

Mode 1: *Ecouter* (information-gathering). This is where our attention is interested in the immediate identity of the sound.

Mode 2: *Ouïr* (to hear as passive reception). This is the lowest level in our auditory perception where we cannot help but *hear* the sound, but there is no intention to *listen* or interpret meaning. We exercise this listening mode every day in connection to background noise.

Mode 3: *Entendre* (responding to intrinsic properties of the sound). With this mode we ignore any meaning behind the causation and focus on purely spectral phenomena.

Mode 4: *Comprendre* (the coding of a musical language). Here sound is only the vehicle for the meaning. The practice of entendre is intended to lead to the emergence or structuring of a musical 'language'.

Modes 1 and 2 according to Schaeffer are spontaneous, universal and referred to as natural listening. Modes 3 and 4 are cultural – they require learning and cannot be regarded as universal. Schaeffer aimed to use the mode 3 approach to create a complex musical language ignoring referential aspects in the sound, proposing 'reduced listening' – where the listener concentrates only on the sound's inherent features. However, common experience tells us that it is nearly impossible to ignore referential information. Our perceptual mechanism has been biologically conditioned to explain causation and find meaning. Developing an entire musical language based on mode 3 listening is therefore unrealistic. But there are some exceptions. When working in the studio composers often experience reduced listening through intense repeated listening. With sufficient repetition within a composition, a normal listener may gain a similar experience. Steve Reich's tape work *Come Out* detailed later in this chapter approaches these criteria.

Michel Chion, who from 1970 worked as Schaeffer's assistant, prefers to explain three listening modes (Chion 1994, pp. 25–30). Chion's *Causal Listening* is where we listen to the sound in order to gather information (similar to Schaeffer's mode 1). *Semantic Listening* refers to a code or language that is needed to interpret the message (similar to Schaeffer's mode 4). *Reduced listening* is as Schaeffer explained. Chion therefore does not consider the act of *hearing* (the passive reception of Schaeffer's mode 2), only of *listening*.

Denis Smalley presents another variation by explaining greater cross-referencing between listening modes. Mode 1 perceptions may be culturally conditioned and therefore influence the syntax formed in mode 4 listening. In fact, one sound may be experienced as traversing *all* modes of listening depending on context. As Smalley clearly illustrates, if you mix a car sound into a surreal car-scape, mode 1 listening is most important. Whereas if you place the same sound in an acoustic instrument context, then its intrinsic – or mode 3 attributes – are more highly weighted within the complete context. Smalley suggests that our common listening experience is one of forming varyingly precise or vague mental connections to an idea of a source-sound, to a scenario, or to an idea of physical energy. In some shorter duration circumstances, when a sound is extremely abstract, the strength of referential images may be so vague that the ear is more attentive to a mode 3 listening state. Over longer durations, context will lead our perception through all modes of listening as new information is revealed.

In broader terms there are many ways to listen, and music is often designed specifically for these listening strategies. Religious music, political music, music intended for meditation and music intended to encourage other activities are common. For example, the allegory of political oppression in Trevor Wishart's *Red Bird: A Political Prisoner's Dream* (1978) clearly conditions the listener's approach. Pauline Oliveros's 'Deep Listening'

suggests a multifaceted listening approach intended to evoke a heightened state of awareness.[1] *Muzak* plays on passive reception to encourage us in some other activity. The flip between passive and active reception finds its way into other types of music depending on the individual listener. Many listeners will flip between passive and active reception in response to lengthy minimalist structures, to overtly complex music or as a meditative act.

Schaeffer and his closer relations

Solfège of the sound object

In the *Esquisse d'un solfège concret* Schaeffer documented what he experienced during the working process from sound through to composition. This process began with the act of recording. Sound was then classified based on length and centre of interest without aesthetic or technical analysis. The next stage involved value judgements on complexity and how the ear may isolate aspects such as repetitive or thick sound complexes, or amplitude envelope morphologies prior to any sound processing or composition. Processing operations prior to composition are then discussed, based on how much the sound is altered from its original, and how much variation is applied to pitch, intensity or timbre. Finally Schaeffer discusses compositional processes such as the use of juxtaposition (montage), superimposition (mixing), instrumental sound and spatial issues connected to performance.[2] Schaeffer points towards the importance of perception yet separates sound processing from composition (a link that is now generally accepted as inseparable), but we can speculate that this separation possibly resulted from the era's labour-intensive tools. Likewise, spatial issues are seen primarily in a performance context, whereas our current technology allows the composer to embed spatial issues more deeply into composition.

The development of Schaeffer's theories and Spectromorphology

Spectromorphology, a term coined by Denis Smalley, is a concatenation of two words: *spectro* (spectra) and *morphology* (knowledge of shape). Typically, spectromorphology refers to the dynamic shaping of the sound-spectrum through time. Within spectromorphology Smalley embeds Schaeffer's theories while refining the perceptual approach. Smalley's aim was to present a comprehensive terminology for describing and analysing structural relations and behaviours *as experienced* in a multitude of Western musics and musical thinking, rather than outlining a methodology or to forge a new musical language. Some of the most important differences between Schaeffer's solfège and Smalley's spectromorphology concern this connection to the listening experience, and in doing so spectromorphology may also be used as an analytical method for many styles of Western instrumental

music. In summarising Smalley's approach it is useful to first discuss *indicative fields* and *networks*. *Indicative* concerns the message in the sound, the link between human experience in a non-sounding world and musical perception. The indicative field can be regarded as beginning in Schaeffer's listening mode 1 and then spreading into mode 4 as the musical context develops. Nine indicative relationships are identified. Three are listed as archetypal and attached directly to our physical selves: *gesture*, *utterance* and *behaviour*, while the remaining six are: *energy*, *motion*, *object/substance*, *environment*, *vision* and *space*. Further, the idea of *surrogacy* is introduced concerning gesture and the supposed human presence behind the creation of the sound. It is however easy to find 'surrogacy' as pertinent to all the indicative relationships.[3]

Field refers to any one of the nine classes when regarded separately. *Network* is used to refer to an interdependent network of many fields surrounding a central field under focus. Smalley suggests that indicative fields cannot include 'compositional models based on scientific, mathematical, statistical or other theories, regardless of any universal validity', as these models cannot be understood without explanation. Here we may observe a difference between the concepts of Smalley, Xenakis and compositional techniques involving numerical data.

Delving into the sounding world fully embraces the original spectromorphology arguments. The main points of consideration are: the spectral typology (continuum between note and noise), morphology (temporal shaping archetypes), motion typology (motion analogies), motion style (the internal details of the motion typology) and spatial settings (acoustic analogies and pitch-space settings).[4]

Although spectromorphology is a descriptive tool based on aural perception, it has clearly influenced a great number of composers and compositions. Often a composer will use spectromorphological analysis techniques to clarify what has emerged from a compositional process, and then take the results of this analysis as a point of departure for further development.

In recent years, software that allows fine control over sound transformation has facilitated a greater exploration of motion morphology counterpoint, which the reader will hear by comparing early analogue techniques with later works employing computer tools. To draw from Smalley's own works, *Darkness After Time's Colours* (Smalley 1976) and *Valley Flow* (Smalley 1992) both strive for counterpoint rather than montage, yet the motion counterpoint in *Valley Flow* is clearer and more controlled in its musical purpose, particularly from 5′35–9′50.

Tape techniques and repetition

Compositional ideas stemming from the tape techniques of montage, mixing and looping have prevailed independently of the media and are common

in all forms of composition and music production. Schaeffer's first attention to repetition was in *Etude aux chemins de fer* (1948), composed almost entirely from a succession of repeating sounds. The fact that the tape recorder allowed identical replay was later exploited in Steve Reich's *Come Out* (1966). In this work we hear a gradual abstraction process – where repetitive rhythmic organisation of text fragments emphasises phrase, rhythm and pitch over semantic meaning, placing the listener in a Schaefferian mode 3 position. In Luc Ferrari's *Unheimlich Schön* (1971) the repetitive phrase is somewhat longer, and combined with an intense intimacy and clarity of closely recorded text and breath sounds the listener may feel a simultaneous and paradoxical need for listening with modes 1, 3 and 4.

Musical hierarchies constructed from repeated units of lengths ranging from a few seconds to many minutes can be found in all musical genres in both western and non-western musical systems. Works as different as Birtwistle's orchestral *Earth Dances* and Stockhausen's electroacoustic *Kontakte* are constructed from complex synchronic relations between short loops and cycles of greatly varying timescales. Yet the possibility of creating exactly repeated loops and finely controlled microscopic changes in cyclic constructions is unique to the use of tape or computer tools. In the following I focus on that which is perceptually relevant to exactly controlled repetition and variation and therefore inaccessible to acoustic instrumental performance.

Streaming effects and emergent information

A complex unit of sound created by micro-sound editing, sequencing, montage or transformation effects, or by selecting a single complex concrete sound, may yield a seemingly random arrangement of amplitude and frequency variation when played through only once. Repetition of this unit produces streaming effects revealing rhythm, pulse, phrase, complex syncopations and polyrhythms. The maximum possible duration of the unit for the streaming effects to be audible is connected strongly to the type of sound material, its complexity, and the attentiveness and skills of the listener, often defying any rule base and requiring aural decisions. A composer may control the emphasis of different emergent effects by changing the speed of playback, timbre, relation between internal details, internal complexity, duration, or by substituting or removing information. As the loop increases in duration, or as the variation increases, the ear is less able to group similar information and deduce the resulting streams. Thus the composer leads the listener from a beat-driven experience to one where other aspects are more immediate.

Over short listening durations we find a commonality between high art and many popular electronic structures. The point of departure is found

when we look at simultaneous layers of information, development over longer durations, in the complexity of the syntax and ultimately the function of the music in relation to the listener and demands on the time span of attentive listening. To illustrate we can consider a seventeen-minute example interesting in its simplicity: François Bayle's *L'aventure du cri* from *L'expérience acoustique* (1970–2). As the music unfolds, three main layers consisting of slowly changing looped units, of greatly different duration and with varying degrees of surrogacy, weave in and out of focus. That which is set in counterpoint is unified by a common pulse, yet the listener needs to maintain attention throughout the work. In Luc Ferrari's *Les anecdotiques* (2001–2) we hear an alternative approach where the natural morphologies of spectrally and anecdotally complex sources are gently teased to subtly combine natural and studio edited repetitions, rhythms and cycles.

Voice and language in an acousmatic world

Language and utterance provide a rich set of source materials for composers, and their use far predates electronic media. Our voice is our primary expressive instrument. We all recognise vocal sources and it is nearly impossible to disentangle vocal and human associations. The voice is an indicator of complex emotional states as well as a carrier for communication. In a compositional context we may consider whether it is desirable to distance ourselves from the emotional content of the utterance to allow its musical role to be heard. If we consider Berio's *Sequenza III* (1966), analysis of the score reveals the compositional structure. Yet on experiencing a live performance the emotional energy and facial expressions of the live soprano may easily distract.

In Stockhausen's *Gesang der Jünglinge* (1956), Berio's *Thema (Omaggio a Joyce)* (1958) and *Visage* (1961) and in the works of Schaeffer and Henry we hear different approaches to the acousmatic voice. But these examples are isolated cases, rather than forming an aesthetic framework: *text-sound composition* began a clearer lineage (Hanson 1993). The term was first used by Lars-Gunnar Bodin and Bengt Emil Johnson, who from 1967–71 were active composers in *The Language Group* at Fylkingen, Stockholm. Text-sound composition began in acoustic performance as a way forward for modern poetry and literature in the late 1960s. Visuals, rhythm and implication were used instead of traditional metaphor. Sound itself, the method of sound production, and the connection to expressive utterance were more important than semantic meaning. Tape, and later computer resources, facilitated non-performable rhythm, 'pre-linguistic' utterances and the removal of semantic intelligibility. Once semantics are removed, the

possibilities for non-linear forms increase, and parallel event streams become important.

Many composers also use longer text extracts either of their own recordings or from archival material – where the original semantic meaning, the delivery and possibly the identity of the speaker are important – and where tape or computer manipulation changes the semantic meaning in some way. Steve Reich's *Come Out* (1966) and Luc Ferrari's *Unheimlich Schön* (1971) have already been described above. In Paul Lansky's *Idle Chatter* (1985) we hear a texture designed to make it seem as if there are understandable words, but what results is rhythm and harmony created through processing the human voice using LPC (Linear Predictive Coding – a vocoder-type effect), granular synthesis and plucked string synthesis. Other techniques we hear are montage, often combined with sound transformations, creating a hybrid of transcontexts and surreal landscapes. Lars-Gunnar Bodin's *Cybo II* (1967) presents a short illustrative example. In *Vox 5* (1986) Trevor Wishart explores two compositional approaches to the voice: (i) Continuous transformations of vocal to non-vocal identities, making the source (voice) and the goal (other) clear, playing on symbolic connection; (ii) Vocal source transformations that hover in the centre point between source and goal such that dual meaning is found at a single point in realtime.[5]

Working in the extremes of sound: from sine tone to noise

Noise elements are clear throughout the electroacoustic repertoire. In one extreme we can hear Stockhausen's *Microphonie I* as containing significantly 'noisy' sound, yet the role of this noise is of low importance to the work's aesthetical and structural foundation. Noise may also result as a side-effect from some other sound transformation or compositional technique, or be the perceptual result of a spectral densification. We can also identify the use of noise as important to the compositional approach. Here are a few examples: to enhance temporal or spatial articulation, particularly within a microsound approach where shortening the sound grain creates a broader spectrum, such as in Road's *Volt Air* (2003); to mask, obscure and reveal layers in the composition, or temporarily distract the ear, such as in Ambrose Field's *One Hell of a Place to Lose a Cow* (2002); as inherent to environmental or natural materials, such as in Annette Vande Gorne's *Feu* (1986); to inject ambiguity in sound or spatial identity such as in Beatriz Ferreyra's *Vivencias* (2001); or to be explored for its intrinsic character, often set against sine tones and other repeated waveforms, such as in Elio Martusciello's *Hz – limits of the technology* (2000). Noise may also be used with intent in relation to its sociological implications. From a historical perspective, sociological

noise elements in electronic music stem from the Japanese experimental music scene rooted in the punk movement and has very little to do with electroacoustic music. However, electroacoustic composers are also part of society, and if not drawing from punk history, convergent trends – particularly when based on a reaction against social, economic or political forces – will inevitably be found. Many will say that noise is 'annoyance', 'mess' and 'disturbance'. Others may say noise is beauty (as a reaction against stereotypes of beauty?), while many cultures associate noise with death, and in general noise as sound tending towards entropy (the 'end?'). How we perceive and approach noise changes continually – the historically shocking sounds of Russolo's *intonarumori* or noise machines are by today's standards tame.

Two recent, related trends are apparent. The first uses either a high percentage of coloured noise or broadband signals. Any sound without restriction may be used, but always significantly distorted in some way or behind the veil of a partly masking noise component obscuring referential sound information. With the problem of simultaneous counterpoint (due to masking effects) temporal ideas involving either microsound approaches, slowly changing masses or clear articulation necessarily predominate. The music is often intended to be played at a volume that pushes the listener to a state of sensation rather than conscious listening, and thus structural organisation is essentially of low importance. Often played over the threshold of pain the body begins to 'feel' rather than 'hear' the sound vibrations (particularly when bass frequencies are emphasised). Without ear protection the volume and density of sound may push the listener to a state of 'obliteration'. With ear protection the body will clearly feel the pressure waves, while appreciation of the 'obliteration effect' will remain conceptual. For an example the reader can delve into the experimental noise records of Japanese musician Masami Akita (Merzbow). The second trend stems from improvisation practice. Often using a variety of electronic sound-making devices or drawing from a wide realm of concrete sound, the sound worlds are generally more varied, as is the resulting improvised approach to structure. These two trends form the extremes of a continuum between which a vast amount of live electronic music exists from around the globe. For further discussion the reader is referred to other chapters in this companion.

Space

Spatial elements in acousmatic music are inherent to the art form, in composition and in the projection of music to the listener. Whether spatial information is bound up in the sound as composed, or whether spatial information

is the result of the sound as played back in the listening space, sound and space are inseparable. As the perception of, and interaction with, our spatial world is vital to our every day it was inevitable that composers would find the need to draw spatial-structural functions into their music. Our current spatial aesthetics originate in three integrated sources: (i) conceptual visions, such as that of Varèse's interacting and colliding sound masses (Varèse 1971); (ii) specific recording and sound transformation techniques allowing the composer to capture and control spatial information within a controlled studio environment; (iii) solutions for taking a work from the studio *single listener* situation to a concert hall *many listener* situation.

In 1950, Schaeffer and Henry created a series of works using up to five tape signals routed to a four-channel speaker system. The speakers were arranged in a tetrahedral configuration, with Front Left and Right, Back, and Overhead. To facilitate distribution of the sound Schaeffer conceived a mechanism called the *potentiomètre d'espace* (1951) where a performer could control the spatial movement by hand as a performance action after the musical aspects of the composition were fixed. Cage's *Imaginary Landscape No. 4* (1951) used twelve radios, twenty-four performers and a conductor. At each radio, one performer controlled the frequency and the other controlled the volume. In the following year, *Williams Mix* (1952) for eight mono tapes was played through eight equally spaced loudspeakers surrounding the audience, and was the first work for eight-channel surround sound. Edgard Varèse's *Poème électronique* (1958), which was presented as part of a multimedia environment at the Philips Pavilion at the Brussels World's Fair, used three tracks distributed dynamically to 425 speakers via an eleven-channel sound system. In these historic examples the spatial element was an experiment in performance. The first true spatial composition conceived prior to the act of performance was Stockhausen's *Kontakte* (1960), consisting of a quadraphonic channel arrangement for front, left, right, and back speaker positions. In order to create the effect of sounds *orbiting* the audience, in the studio Stockhausen placed a loudspeaker on a rotating turntable surrounded by four microphones. In concert, the loudspeakers were placed in the same geometry as the microphones were previously. Thus the rotation effect is remarkable due to the recording capturing the real acoustic situation rather than attempting to synthesise the complexity of reality.

In the late 1950s François Bayle joined the GRM (Groupe de Recherches Musicales). Besides his music, Bayle has been the driving force behind two important technical developments influencing the aesthetics of acousmatic composition. The first is the development in 1974 of the *Acousmonium* – a loudspeaker orchestra for performing fixed works. The second is the support he gave to technological developments in sound transformation technology. The Acousmonium can be seen as an instrument for projecting

the qualities of the music to a large audience – qualities otherwise only possibly understood by the single listener, situated in the perfect position, in the studio. Performance issues connected to sound diffusion may also be considered while composing, such that two mixes of the same work may be made: one version for diffusion performance, one version functioning in stereo or home listening situations.

Since its establishment, the concept of the loudspeaker orchestra as a performance instrument can be found worldwide. In France and Great Britain there are at least four large touring systems – the Acousmonium of GRM, the Gmebaphone of Institut International de Musique Electroacoustique de Bourges (IMEB), the Birmingham Electroacoustic Sound Theatre (BEAST) and the Motus-Acousmonium – of one of which most composers of electroacoustic music would have had first-hand experience. Contrary to what we sometimes read, the loudspeaker orchestra as a performance tool for acousmatic music is active and very much alive outside academia. Although the influence of the loudspeaker orchestra on compositional aesthetics is somewhat tenuous, it cannot be denied that on listening to a skilled spatialisation or sound diffusion performance the thrill of sound-space exploration is difficult to resist. Outside contemporary music circles spatialised sound is commonly encountered in most cinemas. However, this spatial information is normally for sound effects rather than for musical structure, and the possibilities for spatial interplay are often toned down so as not to distract from the film dialogue.

As multi-channel studio systems became more common, multi-channel composed formats were sometimes chosen. Technical solutions to spatial composition are numerous, involving sound recording techniques, transformation techniques, amplitude panning or more advanced sound-field recreation over multiple loudspeakers. Recent developments in holographic and three-dimensional sound projection will undoubtedly bear future implications on composition and performance. It is inappropriate here to argue the technical pros and cons of various methods and instead we shall see how spatial information may drive the compositional structure. In one area we find the use of space in electroacoustic works driven by the instrumental compositional tradition. In the other area we find spatial issues embedded in the acousmatic approach to sound. We shall now concentrate on the latter.

Space and composition

Spatial information is inseparable from sound identity, and can be investigated in a similar way to other aspects of sound. The spatial context is concerned with spatial situations (environments), spatial gestures (motions) and object-space connections. I here attempt to present a general picture by

detailing four main compositional approaches to composed space (Barrett 2002) which can be summarised as:

(i) The illusion of a space or a spatial location of an object created by either spatial acoustic cues, image sizes, image motions or object relationships in terms of volume, frequency colouration or relative motion velocities. Spatial acoustic cues are connected to our understanding of room and environmental acoustics. Here we can include phantom imaging and information indicating the size, shape and materials of an enclosure. Image sizes, image motions or object relationships concern how objects within the space relate to the physical position of the listener and to each other. A simple example would be where a large image size results in a close, wide sound, while a point source may hover, at any chosen point in the stereo width, ambiguously close or far, depending on its relation to other sounding objects or to room acoustics. Similarly, a juxtaposition of sounds with different image sizes, volumes, spectral colour and motions will highlight their differences and define a composed spatial framework. The opening two minutes of my own work *Angels & Devils* (2002) illustrate how these techniques may unfold through the musical structure to set the spatial framework for the rest of the composition. Horacio Vaggione's technique of composing musical spaces by means of decorrelated audio channels (Vaggione 2001 and Roads 2005) explores the subtleties inherent to the illusion of space without delving into room acoustics or acoustical analogies, and can be heard in *Argon* (1998). Likewise, when the spatial resonance or material properties within the physical dimensions of a sounding object are captured by stereo or multi-microphone close-recording techniques, the results are heard in the context of the spatial illusion. Jonty Harrison's *Klang* (1982) clearly presents a compositional process beginning with this recording technique. Trevor Wishart lists a great number of example motions in the horizontal plane (Wishart 1996, chapter 10), but the reader should be aware that these are isolated from real natural spatial morphologies and from commonly experienced biological models involving social spatial interaction.

(ii) The allusion to a space or a spatial location of an object created by associating the sound with, or by placing the sound within, a space that is appropriate based on its identity.[6] By changing the sound allusion, the spatial landscape will likewise change. Allusion may involve an implicit awareness of the source bond demanding a spatial context, or remote spatial connotations derived from mass, density or non-aural models. Non-aural models are perhaps more important than currently assumed. Emmerson (1998) points out how sound in general evokes

a sense of scene strongly related to our visual experience where 'the science of acoustics cannot any longer alone explain sound phenomena and requires psychological and ecological dimensions.'

(iii) The simulation and recreation of three-dimensional sound fields (with ambisonics or wavefield synthesis) results in spatial clarification by doing away with ambiguous phantom imaging and allows the direct transmission, without performance interpretation, of spatial information to the listener. Additional spatial compositional issues become apparent, such as increasing the possibility of spatial difference, allowing reality mimesis and increasing the number of simultaneously perceptually identifiable sounds. A few ambisonics compositions are available decoded for horizontal quadraphonic or 5.1 loudspeaker systems. My *Exploration Invisibilis* (2003) is one such example.

(iv) The effect of the listener's space is important to all public and private situations. Although I cannot here delve into the perceptual and aesthetic issues connected to the listener's space, we can briefly consider two examples where the performance room is inherently linked to the musical structure. Alvin Lucier, in *I am sitting in a room* (1970), used the acoustics of the recording/performing space as the essence of the composition. A chain of microphones, tape recorders, and loudspeakers were used to generate cumulative reiterations of a source text reading (Manning 1985, p. 199) such that feedback gradually obscured semantic meaning in preference for phrase, pitch and rhythm. Bill Fontana explores recontextualisation by transmitting live sound from one location to another, overlaying naturally occurring sound in the installation space. In *Sculpture with Resonators* (1972–5) microphones were placed inside objects such as large glass bottles, tubes and seashells. The objects were placed on the roof of a building, the natural sound environment being filtered through the resonance of the container, and the result played in the interior of the building. Fontana states, 'Most people use their visual perception to tune out and not pay attention to ambient sounds of a given space. By carefully placing naturally occurring environmental sounds in a space where they normally do not belong, this perceptual masking technique is defeated and people are confronted with sounds they cannot ignore' (Rudi 2005). Extreme separation in microphone placement effects a spatial re-composition, and not only spatial replay.

Sound diffusion: the final stage of composition?

Jonty Harrison summarises an approach to performance commonly accepted amongst acousmatic composers, but often misunderstood in other contexts. This approach regards sound diffusion as a continuation of the

compositional process where the heritage of acousmatic composition is one of 'performing' in the studio. Therefore when performing the music to an audience it is 'appropriate that the same type of "physical" gestures that were used to shape material during the process of composition should be used again in performance to reinforce that shape in the audience's perception and to enhance further the articulation of the work's sonic fabric and structure' (Harrison 1999). This standpoint raises three issues. The first concerns the reality of diffusion automation and multi-track sources. Every performance space, every loudspeaker system and every audience bring their own differences to the totality of the space, and each performance needs to be tailored to function in each unique context – a tailoring less realistic with pre-programmed multi-channel sources. The second point concerns recent developments in the technology of sound field recreation where the spatial performance in the studio may be captured and then exactly recreated in the performance space. What effect does this have on composition and diffusion practice? The third point concerns the composer without access to a diffusion system. Does this mean that the composition is in some way less valid when heard in stereo at home, or when interpreted by someone else?[7]

Microsound

Analogue and later digital editing techniques have allowed the composer to control extremely short time durations and micro-sound details which have led to some characteristic aesthetic decisions. We can say that all music falls into the continuum between three timescales: micro (from the threshold of perception or microseconds up to short sounds), meso (a local rather than global timescale grouping information into durations measured in seconds) and macro (the entire work or the long term, subject to large differences in what each individual remembers) (Roads 2001, pp. 3–41).

Stochastic, algorithmic and numerical control of sound

Control over micro-sound details may result in a variety of sound types and approaches to temporal structure. We may hear continuous, smooth, spectrally simple tones, highly textured sound masses with large internal variation, continuous morphological change or sound identity abstracted through micro-sound decomposition. Since the mid-1990s these techniques have been readily available in low-cost granulation software running on home computers, such that they have infiltrated most sound and music creation. Here I focus on the use of micro-sound control as inherent to the compositional process.

Control over the micro-level connects to all temporal levels of structural organisation. As it is often unrealistic to control individual sound particles, some high level control is needed. A variety of solutions to this problem have been applied. Xenakis's approach drew from the statistical theories of physics, which enlarged the previously strict principle of causality and observed an evolution towards a stable state or a *stochos* (from where the word stochastic is derived). Embedded in this theory is a multiscale approach to composition, where operations on one timescale generate structures that may be perceived on other timescales (Roads 2001, p. 331). In 1956 Xenakis completed the short study *Analogue B*. Sine tones were recorded on analogue tape, cut into hundreds of fragments and then laboriously spliced together. In this systematic and hand-controlled technique every sound could be understood as the assembly of a number of elementary particles (Roads 2001, p. 65; Xenakis 1971). In 1991 he began working on a programme called *GENDYN* (at the CEMAMu). *GENDYN* explores stochastic timbre constructed from waveform fragments controlled by probability procedures. The computer generates the sound and steers the compositional process as integrated entities, binding macro- and microstructures within one process. This is clearly heard in *S.709* (1994). I encourage the reader to explore the inventive legacy left by Xenakis through his other electronic and orchestral compositions. Xenakis's original interest in stochastic theories stemmed from what he saw as the crisis of serial music, discussed further in chapter 6. Many aspects of Curtis Roads' work – both as composer and researcher – have been embedded in the micro-sound aesthetic. In *Prototype* (Roads' first study in automated granular synthesis from 1975), fourteen interacting synthesis parameters described the global properties of a sound cloud filled with grains. As one parameter is varied other parameters linked to it also change. 'The connection between the parameters was not a simple linear scaling function, but rather a linkage between their degree of order or disorder' (Roads 2001, pp. 303–5). Since this time Roads has developed a number of synthesis techniques used by himself and others. The collection of compositions on *Point Line Cloud* (2003) presents a clear insight into Roads' aesthetic orientation.

Barry Truax, since the 1980s, emphasised a realtime stream-oriented approach to granulation implementation and the use of natural (acoustic) source sounds. Truax's connection to the soundscape aesthetic will be discussed later. Here we draw attention to lengthy time-stretching using granulation. To control granulation in realtime Truax developed the GSX and GSAMX systems. These allow the user to exercise different levels of control over grain parameters for realising planned structures or spontaneous improvisation. In *Riverrun* (1986) the listener will hear a temporal structure flavoured by the realtime aural approach.

If we regard micro-sound control as an aesthetic approach to the connectivity of material and structure, we see that high-level control algorithms are but one possibility. It is common for acousmatic composers to temporally connect material and structure using bottom-up manual arrangements of materials. Many of Horacio Vaggione's compositions are clearly illustrative, created by the manual placement and mixing of micro events. Through this labour-intensive approach we hear multi-scale relationships in parameters such as amplitude, duration, gesture, articulation and spatial imaging. *Argon* (1998) provides a clear example – 'Vaggione refuses to dissect music into sound objects on Schaefferian terms. Composition should not rely on juxtaposition, it should superimpose different processes into a sort of polyphony' (Risset 2005, p. 289).

In general terms we can see that the morphological archetypes and motion styles described earlier are likewise sculpted across micro, meso and macro timescales, relevant to sound transformation and as structural functions. Whether we perceive gesture or texture as dominant hinges on perceptual timescales and on the attention of the ear. On a micro timescale, attention to internal components of a gesture results in predominantly textural listening. Over a meso or macro scale the material will clarify larger contours and motion trajectories and gestural listening predominates. Whether the music is gesture- or texture-carried is thus guided by temporal unfolding, how extrinsic information may lead the ear, and inevitably whether the listener is new to the work and gradually gathering information, or whether a listening scheme has already been constructed.

Other types of high level control are also common. Non-audio numerical data describing, or extracted from, the natural world can be used as a template to create material or control musical structures. The mapping rules are particularly important, and if correctly chosen the musical results are *perceptually* understood as approximating to one of Smalley's indicative fields. For example, an avalanche model may create falling and cascading gestures implying both avalanche and more general second-order surrogacy. Likewise, spatial environmental data can be used for the more accurate control of the spatial distribution of sounds in the composition – strengthening the perception of *environment*, even when using sounds of vague connection to our real environment (Barrett 2000, pp. 20–3).

Connecting to the environment

Xenakis's early work *Concret PH* (1958) is assembled from a vast quantity of one-second extracts from a recording of burning embers and illustrates how some acoustic sound contains a naturally occurring statistical distribution

of grains. Such properties are inherent to nearly all environmental sound, and most acousmatic composers have explored this feature in their music. Yet sound from the environment offers more. It is to this area we now turn.

Soundscape composition

Creative approaches to our sound environment show a great diversity in composed versus natural structures. Chris Watson, who works as a freelance sound recordist, specialises in capturing wildlife sound environments that in our everyday we will rarely experience. Many listeners will have unknowingly heard his recordings in the soundtracks of well-known BBC nature documentaries. Since 1996 he has released his recordings on CD. In early productions such as *Outside the circle of fire* (1998) each track presents one sound recording. In later releases such as *Weather Report* (2003) some compositional rearrangement is employed. Unlike Luc Ferrari's approach, where it is clear that a variety of subtle approaches to composed forms and narratives are used – including using the microphone to 'search' for sounds specific to the composition in hand and forming a moving spatial perspective (particularly clear in *Presque rien No. 2* from 1977), Chris Watson's work up until now maintains a purity of documentation in its relative detachment from compositional intervention.

'Soundscape composition' is often used as a descriptive term, yet its meaning is vague. Hildegard Westerkamp explains that soundscape composition involves more than the mere use of environmental sound. She suggests that soundscape composition is not driven by the sound materials used in the work, but by 'deeper issues that had brought it into being: issues of environmental listening and active engagement with our soundscapes' (Westerkamp 2002). In this light, soundscape composition stems from the study of the interrelationship between sound, nature and society – or the stance of the composer listening to the world from an 'ecological' perspective. Westerkamp describes the approach more as a way of life than as a contained compositional aesthetic: 'the actual recorded materials are of course important, but the listening experiences while recording and while going about one's life are just as important and so always figure into the compositional process in some way.' With conscious listening and an awareness of our role as sound-makers, soundscape composition may be aimed at enhancing environmental listening, and is necessarily rooted in the themes of the sound environment. Westerkamp works with composed forms involving significant sound transformation and montage, experimental radio series blending soundscape documentary and commentary and 'soundwalks'. 'Soundwalks' are a way of actively participating in the soundscape through following a map – which can be interpreted as a score – where sound landmarks are identified. The participants are encouraged to

make critical judgements about what they hear and even explore their own sound-making in conjunction with the environment. Truax supports Westerkamp's proposal, in that instead of listening being the end stage we can regard sound as mediating the relationship of the listener to the environment (Truax 1992, p. 377). Truax provides a list of specific trends in soundscape composition as developed at Simon Fraser University from the 1970s which may be summarised as approaches to material and approaches to structure (Truax 2002).

Landscape, the transformation of sound images and metaphor

Truax's all-encompassing perspective suggests a continuum from the real soundscape to the composed landscape where sound transformation, temporal structural rearrangement, sound images and metaphors gain importance.

Pierre Schaeffer's and Pierre Henry's early work *Symphonie pour un homme seul* (1949–50) relies to some extent on the listener recognising the source of the sound. This approach was afterwards rejected by Schaeffer. Later, Luc Ferrari embarked on a deeper investigation of the idea of landscape through careful sound selection and organisation. In *Presque rien No. 1* (1970) Ferrari takes a recording of activity on a beach lasting several hours and edits the material to twenty minutes. He does not attempt to change the scene, only intensify activity via careful microphone placements[8] and editing techniques. This approach Ferrari describes as *anecdotal*. He aimed to tell stories by bringing together extracts of reality while retaining the structural qualities of Schaeffer's musique concrète.

Trevor Wishart proposes an approach identifying three features of a landscape hinging on the extrinsic nature of sound: (i) the nature of the perceived acoustic space, (ii) the disposition of sound-objects within the space and (iii) the recognition of individual sound-objects. Wishart further suggests that the natural ambiguity of sound allows transformations impossible in the visual domain and the free manipulation of metaphor. This may involve a direct link from sound identification, or an indirect link from, for example, behaviour to connotation then to metaphor. Metaphor, myth and sound archetypes are not used for storytelling in a radiophonic or dramaturgical way, but as a way to unfold non-linear structures and relationships through time (Wishart 1986). When working in this way composers should be aware of whether everyday listeners form similar connections to the sound in its musical context. Likewise, as history proceeds, what is familiar also changes.

Jean-Claude Risset approaches the transformation of sound identity and sound archetypes by combining synthesised sound with acoustic sources from natural soundscapes. This approach takes advantage of the way acoustic sounds are constrained by their activation (hitting, scraping, blowing),

and the way that synthesis is unlimited in its malleability yet restricted in the spectral and spatial morphological details characteristic of real-world sounds. With synthesis he creates a virtual world without a visible physical counterpart, while with acoustic sounds maintains a foothold in reality, effortlessly moving in and out of these worlds within the composition. Risset's acousmatic compositions *Sud* (1987) and *Elementa* (1998) along with Risset's own explanations (Risset 1996) provide useful insight.

Expansion from an instrumental aesthetic

Experimental sound art since the 1950s has harnessed both expensive technology and consumer electronics (see chapter 3). If, however, we study a compositional style that began with basic amplification we find an alternative path. In Stockhausen's *Mikrophonie I* (1964) close microphone techniques are used to capture sounds from a large tam-tam which you would not normally hear. Two performers follow a detailed composed score with directions to scrape, rub and hit a tam-tam while two additional performers amplify the sound with microphones. The way the microphones are used is just as important as the way the tam-tam is excited. The microphones are moved in varying 'rhythms' from the point of excitation, creating dynamics, changes in timbre and spatial information. Twenty years later, with the use of computers, it was clear that realtime modification within a concert or performance setting mainly concerned one or more of three compositional issues: the expansion of instrumental timbre, the expansion of non-instrumental acoustic sources in general and the adaptation of musical structures. Here I will focus on just one example: Boulez's *Répons* (original version from 1981, revisions up to 1988).

Répons is scored for conductor, orchestra, six soloists (cimbalom, xylophone/glockenspiel, vibraphone, harp, piano, piano/DX-7), 4X computer, Matrix-32 programmable patch bay and six loudspeakers. Its realtime technical solutions are embedded within the structure and concept of the work. Although what can now be achieved in realtime is more advanced than in the 1980s, similar motivations are found: to allow the subtlety in tempo that a fixed tape part takes away, to allow the composer to write for familiar instruments while creating a contrast with unfamiliar computer-generated or -transformed sound, to adapt musical structures as a performance action and to capture the spontaneity of public performance (see chapters 5 and 10). In *Répons* we find dialogues between the soloists and the ensemble, between soloists themselves, and between transformed and untransformed passages. Sound from the six soloists is transformed in the following ways: modulation of one instrument by another, frequency shifting, retardation

and changes of phase to create rhythmic motifs, and spatialisation (Gerzso 1984, p. 22), and these processes are often integrated. The spatialisation aspect is particularly interesting due to its integration into the totality of the composition. The six soloists are positioned at the periphery of the concert hall, as are six loudspeakers. The instrumental ensemble is placed in the centre, and the audience surrounds the ensemble. Sound circulates from each of the six soloists among patterns of four speakers. The overall effect highlights the antiphonal relation between the central group and the soloists by making the audience aware of the spatial dimensions. The larger the amplitude, the faster the sound will appear to move (via technical solutions based on note attack-decay characteristics and a team of IRCAM technicians working off-stage). As soloists are independently amplified, a polyphony of spatialised gestures is produced – 'The overall impression for the listener is that of a single spectacular gesture slowly breaking up into several parts. Furthermore, as the overall amplitude decreases, the original impression of sounds moving rapidly around the hall is replaced by a sense of immobility' (Boulez 1988).

In connection to Boulez's *Répons*,[9] Gerzso (1984) writes, 'electronic writing is merely an extension of the traditional writing'. Likewise, many composers to have worked with electroacoustic music at IRCAM used 'electronic writing' as a way to develop or escape from modernism and postmodernism while staying within instrumental traditions. Spectral music – where the frequency components of a sound are used as a framework for structural relationships – has been used by Jonathan Harvey and Tristan Murail amongst others. Although orchestration of a sound spectrum will never result in close approximation of the analysed source (acoustic instruments themselves involve complex spectra and human performance factors can distort the timing), using the spectral and temporal relationship between these frequency components creates an alternative approach to hierarchical structure, helps blend acoustic and electroacoustic timbres (Harvey 2000) and is likewise useful within an acousmatic context. Harvey's tape composition *Mortuos Plango, Vivos Voco* (1980) is particularly successful in this respect due to the audibly clear separation of harmonics inherent to the bell sound source and the clarity of the simple spectrum of the boy soprano voice. Spectral music is however predominantly applied within an instrumental tradition.

Discussion

In this tour through electroacoustic composition and aesthetics I have mentioned only a few personal observations deduced as a freelance composer

submerged within our rich world of sound. The body of the material is strictly historical. There is much I have by necessity needed to omit – the use of sampling and recontextualisation, the world of electroacoustic music involving acoustic instruments, live performance dealing with anything other than spatial issues, sound-art in the context of composition, algorithmic composition and my personal everyday encounter with electronica and electronic improvisation – to mention but a few areas. But what is common to all is that as listeners and composers we are submerged in an increasingly overwhelming sound world. Acoustic sounds no longer predominate our everyday. Did we today really discover or imagine something new in our own work, or did we unknowingly hear the same thing only yesterday in passing? Does it matter? Looking to historical models, theories and works may help us make sense of this world.

One of the traditional approaches for the electroacoustic composer is to descend into the barely audible, finding sources of sound and inspiration in uncovering that which exists but is not normally heard. This approach takes on new meaning as our world of music and sound increases in density, complexity and in literal and metaphorical masking. Perception is fundamental. Calculations, systems, theories, models and contemplation are simply irrelevant if they are not aligned with perception. Although outside the scope of this chapter, perception and cognition lie at the root of the theories and approaches here presented. In the CD booklet to *Etude* (1952) Stockhausen writes, 'Already upon hearing two synchronised layers, and even more so hearing three or four layers, I became increasingly pale and helpless: I had imagined something completely different!'

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