The Interaction of Sound Identities in Electroacoustic Music

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Abstract
Electroacoustic music technology allows for the creation distinctive ‘hybrid’ interactions between sounds, since features which define the identity of one sound object (such as dynamic profile or spectral envelope) can be fused with or imposed on those of another. The spectromorphological features of a sound which remain invariant or recognisable through transformation of this kind are termed the idio-morphology, while the characteristics superimposed on the sound are termed the exo-morphology. This paper emphasises the interaction of sound and transformation processes in these terms, as well as the potential for processes of sound transformation to generate distinctive morphological identities. The material presented here represents the initial expression of an approach to composition based on commonly used digital signal processing tools. Emphasis is placed here on perceptual criteria that are of relevance to the composer’s utilisation and control of signal processing routines, and which ultimately may provide useful perspectives on more widely applied music analysis.

Keywords: electroacoustic composition, acousmatic, transformation, sound morphology.

1. Introduction

In electroacoustic music that draws on sounds sampled from the real world, a strong aesthetic is now established in which sound’s spectromorphological features and referential meanings are regarded as complementary dimensions in the creation of musical structures (Smalley, 1992; Truax, 1996; Wishart, 1996; Young, 1996). Since our ability to separate these two basic dimensions of sound appears to be an innate part of our perceptual mechanisms, as outlined in Schaeffer’s discussion of ‘modes of listening’ (Schaeffer, 1966), the scope for the composer to orient salient aspects of a works structure through and around these distinct types of listening is critical to developing an understanding of how electroacoustic music can function. Digital signal processing techniques allow ever more precise control over the assembly and disassembly of sound-objects, quickly allowing radically new sound identities to be formed from existing ones, to the extent that Wishart (1993) has called for a shift in the conception of musical structures from architecture to chemistry. But digital tools also offer unprecedented scope for mediation between these poles of spectromorphologically and referentially weighted types of listening. The matrix of sound transformation possibilities with digital tools is so far-reaching that frequently composers set processing routines in motion without clearly (or even remotely) knowing the exact sonic outcomes of the processing. In these terms, Boulez (1988) has written of the need for composers seeking musical innovation to free themselves from instinctual patterns of invention. Arguing that musical instinct arises from conditioned and culturally-defined patterns, he suggests that radical and detached formalist processes are necessary for the discovery of new forms. At another level, Vaggione (2001) argues that since ‘music itself’ cannot be defined, we cannot circumscribe at a universal level the methods or principles by which musical structures are devised, but that composers ‘build musical situations by creating constraints that act as reflecting walls inside which a tissue of specific relationships is spun.’ Burt (1996) has outlined a view of algorithmic composition in which creative action is sustained by ‘gambling’ on unknown outputs, through which the composer is receptive to the possible ways in which a notion of musicality might be extended or, as Burt describes his own experience, algorithmic methods serve ‘... to provide me with material that I can learn to listen to.’ In that sense, by ‘allowing’ processing routines to generate musical materials, the outcomes of which may not be fully predictable or even acceptable within the composer’s operating aesthetic framework, algorithmic concerns have become a central aspect of electroacoustic and computer music composition.
In the broadest sense, then, the electroacoustic music composer is, in the terms advocated by Boulez (above), automatically in a strong position to create radically new materials and forms. In particular, composers working with sounds sourced from real environments have the potential to form complex networks of relationships between recognisable sounds, transformations which alter the perceived sound-image partially or completely as well as the morphological signatures of transformational processes themselves. This last point is, in my view, of some significance. Because a signal processing architecture can exist separately from sound itself, it has the potential to be transferable across different music situations—that is, to have a virtual morphology of its own, expressed concretely when applied to sound files.

2. Influence of the composing environment

The application of processing routines to sounds is one part of the compositional chain, however, and not necessarily a justifiable end in itself (since the music is ultimately most likely to be heard independently of the technological context in which it was created). In these terms, Wishart (1986, 1989 and 1997) has warned that use of formally defined processes in a way that treats musical parameters independently of each other runs the risk of invalidating the relationship between compositional process and the music itself when an arbitrary set of musical elements are resynthesised. It is my contention that a musical process does not start until the consequences of a transformation are evaluated and 'comprehended' in terms of some more global set of associations. For instance, the way a sound might be positioned within a broad continuum of sound-object relationships, or the way a composer might judge a set of progressively transformed sounds to be steered away from the 'realism' of the source. In this sense, the global associations through which a work is articulated (cf. Vagione's 'constraints', above) might be reached empirically as the composer develops a working comprehension of the way a certain set of sound materials and transformation processes can interact. At a pragmatic level, Landy (1994) has argued for the importance of coherence in electroacoustic music by putting forward the idea that a material or formal identity which is aurally tangible is essential to allowing a nexus of meaning to radiate through a work, as a 'something to hold on to factor'.

One of the features of acousmatic practice in electroacoustic music is a focus on intense analytical listening as part of the compositional process and, in these terms, the consequences of algorithmic processing and sound transformation in general are under constant evaluation. This is facilitated by the nature of the studio and its tools: sounds are stored intact on a fixed medium and become available for infinite repetitions, allowing time for evaluation of sounds' structures and their potential formal roles. Whether constructed in or out of real-time the evolutionary phases of sound transformation frequently become the scratch situations in which the composer devises or finds the constraints that lead to musically useful results. These, in turn, may be considered from the perspective of some specific approach to differentiating sound types, such as the characterisations of structure and motion in sound outlined in Smalley's approach to spectromorphology (Smalley, 1997) or the poetic associations of Bayle's i-sound (Bayle, 1988).

3. Sound identity

Smalley (1993) has also pointed to the importance of establishing a concept of sound identity specific to electroacoustic music. He suggests that this is important because the medium is so frequently concerned with processes of transformation and therefore that 'some-thing'—an identity—is undergoing a metamorphosis of some kind. But since the vectors of transformation in electroacoustic music are so multi-dimensional—including timbre itself—the identity bases to which transformations are anchored is of the greatest significance to forming an understanding of the dynamics of transformation-centred structural processes.

The concept of identity is significant in music, since it is through delineation of sound identities that we can grasp the relationship between thematic elements and the processes used by the composer to develop and shape them. In the most general terms, sound identity can be projected by one of two aspects of the familiar duality of source recognition and intrinsic sound shape:

1. the source object or auditory scene associated with the sound (actual or imagined), and
2. the spectromorphological features of the sound, including dynamic profiles and the shaping of frequency content within these.

In addition to these sound-source related aspects of identity it is also possible to consider certain electroacoustic sound-shaping processes as having identity characteristics. Where a transformation process is characterised by dynamically changing values and a progressive reshaping of sound occurs to some distinct or transferable tendency whose imprint can be applied to different base sounds, we can regard this as a transformational morphology.

4. Listening contexts in and around transformations

The composer's knowledge of sound sources and the steps and decisions taken to effect their transformation may, in the course of the compositional process, influence the perception of musical relationships. This potential position of the
composer as 'privileged listener' must be taken into account if the musical functions of the complex sound-shapes and structural processes of electroacoustic music are to be more widely appreciated. It becomes essential to develop conceptual models which embrace the musical relations and functions made possible by the transformation process.

The following series of sound examples illustrates one perspective on this. A sound source is processed with a brassage technique (the widely used GRM Tools shuffler). In the first example, short discontinuous 'snapshots' of the input sound are presented though very low-density output from the underlying brassage process. In subsequent examples the density of the reconstruction is increased, and a feedback loop introduced into the processing. The process of continual increase in density in the sound's reconstruction through brassage makes its source increasingly clear. Within the first few examples the vocal origin of the sound may become noticeable, until finally the exact text is recognised (a well known one in English). Examples 1 - 8

Once the original source has been heard, and recognition definitively achieved, we can listen back to the initial stages in the transformational sequence and mentally reconstruct the complete original speech from the traces of it that are presented. At that point we are put in a privileged position where our ability to comprehend the effects of processing is given new focus ... by knowing the original sound source, we can judge the amount of psychological 'distance' between the sound's original state and the transformations of it. This is the situation frequently faced by acousmatic composers where, by having 'inside' knowledge of sound sources, one has the potential to make compositional decisions that are based on a more complete knowledge of the material than the listener may otherwise have. While listening conditions in the acousmatic studio allow and encourage the most concentrated repeated audition, processes of transformation may carry the material beyond the first-time listener's ability to vicariously relate the processed signal to the original material, while the danger remains that the composer may psychologically invest what he has previously heard in the source material. This is made more complex by the number of stages in which we are able to interpret sounds drawn from realistic contexts. For instance, on the first listening to the series of sounds presented, one might detect the distinctive vocal quality of the material quite early on, though the text itself remains obscured. Furthermore, certain distinctively emphasised vowel formants might be taken as the salient structural features, especially since these would be relatively easily used as transferable spectromorphological features imposed on other sounds.

It is obvious in the first example that the transformation generates a new dynamic morphology. This nature of this is circumscribed by constraints placed on the process where, in this case, there is scope for 5.7% of 44ms long fragments to be output by the algorithm. So the generic conditions are created for the production of discontinuous fragments of sound (because of the underlying randomness of the process, precise replication of the exact object in example 1 may not occur). The way the transformational process interacts with the input sound is dependent on constraints placed upon factors such as grain length or delay—for instance the grain length may be set so short that recognition of traces of the original vocal sample may not be possible. At that point a transformational morphology could be set in motion, involving some incremental change (random or determinate) imposed on the parameter values of the process, whereby the textural directions of that morphology could be comprehended separately from the sound that carries it. This distinction is meaningful even if for, say, a non-specialist listener, the transformational morphology is 'understood' by way of analogy with that listener's wider aural experience of sound patterns that arise from the accumulation of small events1. Thus the formal function of a transformational morphology might be the gradual revelation of the underlying source sound (if grains get longer and more contiguous), as well as the articulation of a textural pattern or tendency.

The preceding discussion leads to the following general observations:

1. The way in which a transformational process or sequence of transformations is comprehended by a listener is context-related. The composer must disentangle his/her own privileged contextual listening from those outwardly presented in the work.
2. Even when subject to extensive transformation natural sound sources may retain sufficient aspects of their recognisable features to allow the formation of aurally tangible links between the initial source and the newly created sound.
3. An initial single sound object may be subject to quite different paths of transformation, which may result in little or no perceptual correlation between the initial source and its eventual transformation.
4. Signal processing may result in the production of artifacts that suggest similarity with other sound sources not in context with the initial sound source, (such as the creation of new vowel-like formants in certain applications of granular synthesis).

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1 See also Smalley (1992) for a discussion of indicative fields—general experiential analogies (not necessarily sound-based ones) which may inform a listener's interpretation of sound events.
5. Spectromorphological interaction

Wishart (1996) proposes two dimensions of sound morphology: intrinsic and imposed. This distinction serves to articulate difference between the inherent resonating potentials of a sounding body, and its response to more complex forms of energy input. Complex examples of intrinsic morphologies are also considered by Wishart, where instability in spectral shape is fundamental to the sounding object/energy relationship. These may frequently involve distinct phases of change which allows Wishart to describe them in terms of named (environmentally informed) archetypes.

Electroacoustic music technology allows the composer to explore the interaction and cross-fertilisation of sound materials at a variety of levels, since features of the identity of one sound object (such as dynamic profile or spectral envelope) can be fused with or imposed on those of another. This can lead to the creation of sounds which suggest more than one possible source-cause (Smalley 1993), such that the generative energy of a sound and its spectral content fuse into a sonic hybrid, displaying characteristics of two or more separate identities.

One specific possibility in electroacoustic music is transformation in which one sound identity may influence that shaping of another. Sonic hybrids, developed through the cross-synthesis of two or more different sound identities can be created using a wide range of time and frequency domain based processing methods. Digital technology facilitates the separation of component elements of sound, such as the potential in the frequency domain to separate amplitude and phase spectra, or to use the spectral analysis of one sound as a time-varying filter through which another is passed. Building on Wishart's idea of imposed and intrinsic morphology, a specific concept for the characterisation of sound-images through hybridisation is suggested here, through the distinction between:

- idio-morphology—defining timbral features of sound identities that are nested within transformational sequences, and
- exo-morphology—a feature of a sound that is used to reshape some aspect of the the structure of another.

The relationship between idio- and exo-morphology is context-driven, since the order in which sounds are presented and the nature of their ongoing interactions may influence the impression we form of which sounds are shaping which others. This also attempts to account for the fact that a sound whose morphology is imposed on another may have a further role to play elsewhere in a work, while the idio-morphology of one sound might be shaped by several different imposed exo-morphologies in sequences. Furthermore, many transformation routines can be seen to have idio-morphological characteristics, which function as exo-morphological artifacts or imprints when applied to a sound file.

These are, therefore, not absolute terms, but are put forward here to suggest a way of interpreting the role that the shaping features of both sounds and transformational processes may fulfill in a musical discourse. For instance, a characteristic dynamic envelope used to reshape another sound is functioning within the transformation as an exo-morphology, but in the context of the larger form may also function as a thematic identity by virtue our recognition of the idio-morphology of its dynamic profile in different sections of a work.

The following sound examples illustrate a perspective on this idea, using the time domain technique of envelope substitution. The first example is a multiplex of variously transposed human breathing sounds. Example 9

The second example is a close-microphoned recording of a small bird's wings flapping. Example 10

A composite transformation of these sounds is now created, in which an average amplitude value is taken from the source waveform at 20ms intervals and imposed on the breath mix. 2 The continuous nature of the source spectrum (and the continuous panning of its components) is rendered more fragmentary by the precipitous stereo panning and dynamic shape of the envelope source, while the interaction of this with the panning inherent in the breath sounds adds further level of complexity to the resulting image. There are also sufficient segments of continuous sound present in the envelope source to allow the vestiges of quasi-formant structure present in the vocal sound to be retained. The resulting hybrid of underlying vocal provenance articulated through an unsteady dynamic frame gives this sound a two dimensional character which could have a useful role in the development of a musical structure. The envelope substitution is in fact applied here to two layers of sound—the breath mix and a more abstract high frequency granular sound—with the tight correlations of envelope helping to fuse these timbres within the shape of the exo-morphology. Example 11

A more developed example of this kind of technique is shown in these excerpts from the electroacoustic work Inner (1995), where a dynamically active exo-morphology is used to bring a new apparently 'fractured' contour to the breath's idio-morphology. Examples 12, 13

In terms of musical form-building this has a broader motivation: namely that we can create an ongoing context in which particular morphological characteristics are able to be heard expressed through different sound objects. The idea of distinguishing idio- and exo-morphologies is one concept for

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2 A progressive increase in window length in time domain envelope substitution will result in a gradual change in, and eventually a weakening of, the apparent link between the exo-morphology of the imposing sound and the idio-morphology of the reshaped sound source.
understanding the way identity can function through salient durational, dynamic and spectral characteristics which are transferable—expressible through a sound other than that of the original. This way of viewing musical materials is entirely dependent on context especially the order in which sounds are revealed in a work, but also the consistency with which it is applied. Exo-morphological imprinting is one way of lacing large scale formal focus in electroacoustic music. An example of the use of the envelope substitution technique used to sustain the development of musical phrases is found in Inner. Here, a specific identity (itself the product of time-stretching a metallic sample) is used to reshape the dynamic profile of the subsequent two noise-centred sounds. Examples 14, 15, 16

In next two examples, case the the high frequency granular sound is envelope-shaped by the dynamic patterns of various vocally-derived sounds. Since the high frequency sound is present across the phrases it functions as an idio-morphology shaped by the exo-morphology of the vocal sounds. Example 17, 18

The previous examples all display a process by which the imposition of a dynamic morphology alters the perceived flow of shaping energy within a sound of naturally continuous energy profile. In the work *Pythagoras's Curtain* (2001), many sounds which are essentially impulse-based have been interleaved to generate a sense of causal ambiguity in the make-up of the resulting sound. The following examples involve wave-set interleaving of dynamically energetic sounds (the wave-set is defined in the time domain as a segment containing three zero-crossings). Because the wave-sets (or, in this case, groups of them) form into irregular segments of the source sound, the resulting transformations can have quite disjunct rhythmic properties in relation to their parent files.

Initial sound source: hand claps. Example 19

Next, the hand claps are wave-set interleaved with water splashes, introducing the percept of a causal relationship between the two timbres. Example 20

In the next example, the morphology imposed by interleaving groups of 40 wave-sets of two sounds (a rubber balloon and a tapped crystal glass) generates the percept of more attack-like iterations between them. This produces the semblance of a very ambiguous causal energy/sounding object relationship, reinforced by very general correlations between the two spectra. Example 21

In that example the idio-morphologies of two different sounds are interleaved in irregular (wave-set defined) chunks of each waveform—since the sounds are noisy the wave-sets tend to be irregular in length, and certainly not corresponding to any underlying periodic structure. Because the exact form of the new sound file is defined by the particular nature of each input sound, the exo-morphology that shapes them (the specific rhythm of the interleaving pattern) is uniquely defined by the wave-set structure of the sounds themselves.

6. Sound morphology imposed through transformation

Some further examples of morphologies imposed through transformation processes are given here, taken from sound files developed in the electroacoustic composition *Virtual* (1997). The sound that follows was designed through granular synthesis of a vocal sound (rapid whispering) granulated with minimal stretch factor. The rise across pitch space is an exo-morphology generated by time varying grain overlap, while the vowel-like shifts within the spectrum are a vestige of the idio-morphology of the original sound. A further (new) feature is the registral bifurcation as the spectrum splits into simultaneous upward and downward glissandi. Example 22

The previous sound is now reshaped with two simultaneously layered Doppler algorithms and a pitch shift. The overall upwards trajectory of pitch is retained, as is the barest sense of vowel colouration, but a new rhythmic surface signature has been created as exo-morphology, in which one might think of the Doppler as a spatially articulated amplitude gate. Example 23

We do not have a definite sense of shared origin between the original and processed sounds until, perhaps, towards the middle part of the second sound, where there is maximum frequency correlation with the first, and we get a brief suggestion of its spectral colour. But the new dynamic structure and more exaggerated rise in pitch are imposed features which, because they are defined by assembling processing objects in a fixed configuration, could be imposed on another sound.

The next sound is an enhancement of the above with a spatialised high frequency noise band (the same high frequency granular sound used in the earlier examples from the electroacoustic work *Inner*). My working interpretation of this sound is that the high and low frequency components shift in and out of fusion, though never a complete one. Initially the effect is of two behaviourally equivalent sounds (we hear spectral components rise and falling in relation to the same perceived energy flow). The fusion consolidates towards the end of the sound, where subtlety of dynamic fluctuation, spatial motion and register are more closely linked. Example 24

Now the first sound of this set (example 22) is given a wide-ranging time-varying pitch shift (combined time-varying brassage/pitch shift). One artifact of this processing is the pitched resonance, but the registral bifurcation is retained as a generic link with the idio-morphology of the original. Example 25

The original vocal granulation (example 22) is now source filter cross-synthesised with the
overlapping envelopes developed in example 23. This steers the transformation more overtly back towards the suggestion of vocal provenance, but with the gestural trace of the Doppler-shaped exo-morphology. Example 26

In the preceding series of examples, the cross-fertilisation between underlying sound identities and the shaping influence of transformational morphologies provides an initial set of sounds which articulates some of the matrix of possible relationships between them. These are unified by the consistent basic tendencies of spectral shaping and sound trajectory that are carried across each new sound identity.

In this last example the original vocal granulation (example 22) is source filter cross-synthesised with a turbulent air stream. Examples 27 (turbulent air) and example 28 (cross synthesis).

This final sound is an example of one which is idio-exo-morphologically ambiguous. It is difficult to gauge, even in the context of the sounds from which it is sourced, which might be the imposing or imposed-upon identities. The dynamic shaping of the air turbulence dominates the morphology, but there is also a strong presence of the vocal granulation as an identity which is fused with the spatially active rhythmic component. The 'vowel' shifts and the surges in energy derived from the air turbulence bond quite naturally, so that it is ambiguous as to which of the essential spectral/gestural identities is at the basis of the initiating energy.

7. Provisional conclusions

Two main distinctions in the interaction of sound identities have been suggested here:

1. Source-bound: whereby the morphological characteristics of one sound identity are imposed on another, resulting in the mixing of identity characteristics of two sounds. A particularly strong variety of this kind of transformation can result where the two component identities remain source-recongnisable.

2. Transformation-bound: where the implementation of a processing routine with distinctive sound-shaping characteristics audibly imposes a transferable morphological stamp on a sound.

Both of these imply the transfer of elements of one identity across others, and is derived from an approach to composition where the projection and transfer of morphological identity through musical structures allows the interaction of idio- and exo-morphology to influence formal design. Exo-morphological shaping can act as a trace of consistent identity through a work, while recognition of other sounds' idio-morphologies within this provides one level of timbral and gestural development. In complex musical structures, the resulting cross-fertilisation of sound morphologies (which sound is shaping which?) can lead to ambiguity of apparent source, and the creation of a rich fabric of interconnected and continuously developing sound identities. The consistent utilisation of a distinctive dynamic profile as an exo-morphology may itself be subject to some variation (that is, have its own morphology of evolution) where, for example, the exo-morphology of a brassage process may be characterised by differentiated shifts in grain length or delay/overlap time between grains, with consequent changes in the nature of the processing artifact. The temporal context in which material is presented is also relevant, since this influences our comprehension of the interaction of idio- and exo-morphologies. For instance, do we hear separate sound identities that, once established, are subsequently fused? Does an initial fusion of separate elements later separate into distinct source identities? Do we hear a specific amplitude profile continually recycled with other sound identities embedded within it? In the latter case, the evolution of an exo-morphic identity has the potential to influence long and short term structural design.

In this paper I have attempted to offer a perspective through which the composer can conceptualise the potential for complex networks of sound transformation relationships in electroacoustic music. It is the relationships between a composer's source materials, the effects of transformation on them and the musical/psychological models these might create that continue to require urgent attention in the aesthetics of electroacoustic music.

8. References


