Spectromorphological analysis of sound objects: an adaptation of Pierre Schaeffer's typomorphology

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The last fifty years has witnessed an enormous development with regard to sound production, and has opened a new world of novel aural experiences. In order to be able to articulate and discuss these experiences there is a need for a corresponding novel set of terms and concepts. Such a terminology would also be relevant for analytical and interpretive approaches to electroacoustic music, avant-garde Western music, and ethno music. Pierre Schaeffer's typomorphology, developed in the 1960s, proposed a variety of novel terms, but they have not been of widespread use, since they unfortunately did not lend themselves very well for practical analysis. The present paper intends to develop Schaeffer's approach in the direction of a practical tool for conceptualising and notating sound quality. While carefully reducing the sometimes-bewildering number of terms found in Schaeffer's work, it introduces a set of graphic symbols apt for transcribing electroacoustic music in a concise score. The analysis of sound objects calls for a specific listeners' intention, called reductive listening.

1. INTRODUCTION

In so far as analysis is concerned, Western musicology has focused on *pitch structures* (harmony, modality, etc.), construction of musical *forms* (themes, motives, etc.), and *rhythm* (metre). *Timbre* was traditionally regarded simply as a matter of colourisation of musical structure, and was treated in terms of orchestration.

The electroacoustic music, whose first breakthrough was the *musique concrète* of Pierre Schaeffer and Pierre Henry during the late 1940s, profoundly challenged the prevailing understanding of timbre. The developments in technology and physics that took place during subsequent years enabled humans to mould timbre dimensions and thus to include these as an integral part of a compositional design. The numerous and novel aural experiences of sound made by composers and technicians working in the studio called for documentation and theoretical as well as philosophical reflection, so as to counterbalance the proliferating number of engineering concepts that seemed to monopolise the discourse of electroacoustic music. Undoubtedly, the most substantial response to this challenge has been the work on spectromorphology[1] by Pierre Schaeffer whose *Traité des objets musicaux* (hereafter referred to as TOM) appeared in 1966. It addressed the question of correlation between the world of acoustics and engineering with that of the listener. While the technology he used for his experiments is long since outdated, the overall perspective of the book is still valid. In his approach to listening he provides a number of new categories and concepts that are eminently suited to discuss timbre and sound quality. In consideration of the novelty of its subject matter, the originality of its approach, and its depth of philosophical reflection, it certainly deserves to be regarded as one of the most important theoretical works of twentieth-century musical thought.

Schaeffer's approach to the world of sound is characterised by *a phenomenological attitude*: it seeks to *describe and reflect* upon experience, rather than explain; it posits the actual *life world* experience of sound as its primary object of research ('*la primauté de l'oreille*'); it clarifies a number of different *listening intentions* by which the same physical object may be constituted as various objects in the listener's mind. The capacity to shift between different listening intentions becomes a true sign of the virtuoso listener, and Schaeffer insists that the listener should train his listening even as a musician would train his instrument!

Unfortunately, and for a number of reasons, one of the major achievements of Schaeffer's work, his codification of all sound categories into a grand, unified diagram, remained without much practical consequence. Through my teaching of Schaeffer's typomorphology at the Norwegian Academy of Music since the late 1970s, I have compiled a number of ideas about how Schaeffer's typomorphology could be made into a better

[1]The term 'spectromorphology' is certainly the most adequate English term to designate the vast field of research opened by Pierre Schaeffer and INA/GRM. It was coined by Denis Smalley. He explains the thoughts that went into the creation of the term thus: 'Lorsque j'ai commencé (en 1981) à élaborer un "cadre" (un système) qui me permette d'étudier le contenu de la musique acousmatique sur la base des idées de *Traité* de Schaeffer, j'ai forgé le terme de "spectromorphologie" pour représenter l'idée des composantes du spectre sonore – la matière sonore et le domaine des hauteurs – et celle de leur évolution dans le temps – leur morphologie collective. Le terme combine donc les notions schaefférienes de *matière* et de *forme.* […] Je ne voulais pas non plus utiliser le terme schaefférien de "typo-morphologie", car il n'est pas toujours approprié de se référer à un "type"' (Smalley 1999: 183).

Organised Sound **12**(2): 129–141 © 2007 Cambridge University Press. Printed in the United Kingdom. doi: 10.1017/S1355771807001793

tool for practical analysis. The present paper is a condensation of these experiences; it will present a set of conceptual and graphic tools for the aural analysis of music with an enriched sonic morphology. I have profited greatly from the study of Michel Chion's indispensable work *Guide des objets sonores*. For the revisions of Schaeffer's ideas as well as the digitalisation of the graphic signs, I am grateful for the assistance of Andreas Hedman.[2] The terminology and analytical notation proposed here is solely intended as one out of many ingredients in what would eventually be a fully developed aural analysis of music in general, and electroacoustic music in particular. Music can, in principle, be analysed on three levels: that of sound objects, that of elementary patterns (i.e. organisations, structures) combining sound objects, and that of patterns of patterns (that last one being an analysis of musical form). Music theory has generally concentrated on the second level, taking the first one as granted. We have, through the years in a project entitled Aural Sonology, developed a series of approaches to the aural analysis of level three in particular, by developing means of analysing the music by subdividing it into units (successive segments or simultaneous layers) as well as the characterisation of different functional relationships between these (Thoresen 1985a, b, 1987, 1996). Later a ground-breaking academic work has been done by developing a methodical approach to the analysis of electroacoustic music by Stéphane Roy (Roy 2003). His approach is in many ways parallel to ours. He too finds Schaefferian terms useful in order to characterise basic units (he prefers to call the elements on level one units, not sound objects or musical objects). However, for a more detailed analysis of this aspect of music (level one), our approach offers a greater number of terms and signs.[3]

2. THE ADAPTATION OF SCHAEFFER'S TYPOMORPHOLOGY TO PRACTICAL ANALYSIS

Schaeffer's ideas on the categorisation of sound objects were summarised in TOM in the diagram called TARSOM (Tableau récapitulatif du solfège des objets musicaux). This diagram sums up a number of other diagrammatic representations, of which TARTYP (Tableau récapitulatif de la typologie) is the most important, as it is intended to present a presumably all-encompassing typology of sound objects. Schaeffer and Reibel later illustrated a number of these categories with sound examples in *Solfège des objets sonores* (Schaeffer and Reibel 1966b). Here letters are used to designate the different analytical categories of TARTYP (see Figure 1). Incidentally, Schaeffer makes a few suggestions about how these letters can be combined into small chains in order to describe more complex sound objects in an analytical context.[4] The TARTYP imposes a normative view on the sound objects. Consistent with Schaeffer's intention to identify *musical objects* fit to serve as elements of structure in a new, utopian music, he labels some objects as 'suitable' (*convenable*), others as 'too unpredictable' (*trop originaux*), or too redundant (*trop redondantes*). However, although one entire 'book' within TOM is devoted to the relationship between object and structure, the question of structure, or more precisely, what the nature of musical structures is, is left open. He does, however, mention the need to develop a general musicology, focused on structure (Schaeffer 1966a: 350–1).

Schaeffer's approach to schematisation is original in its emphasis on relativity: it does not insist that every sound object ought to have a corresponding unique location in the diagram. For instance, one sound may be characterised as a *pitched object* (*son tonique*), but since it is a glissando it will be a *variable, pitched object* (*son variable*), and since it is an element of an *accumulation*, it could also fit into that category. This principle may be unusual in a scientific context, but is all the more reasonable from an artistic point of view. The relativity is made acceptable largely because of the strength of the two main axes that organise TARTYP: one is related to *the energy articulation* (*entretien*) of the sound object; the other to the character of *sound spectrum* or *sonic substance* (*masse*). A third dimension, that of duration, enters the diagram as well, as there are three categories of durations that serve to discriminate categories: The short impulse (*micro-objets, duré reduite*), the medium range duration (*duré mesuré*), and the excessively long durations (*macro-objets, duré demesuré*).

Beyond TARTYP, there are a number of distinctions made and summarised in TARSOM, categorised under the columns '*classes*', '*genres*' and '*espèces*'. These are multiplied through the seven *criteria of musical perception: sound spectrum, dynamics, harmonic timbre, melodic profile, profile of the sound spectrum, grain*, and *gait*. In most cases, Schaeffer does not indicate any notation, such as e.g. a letter code that could facilitate the use of his categories in practical analysis.

Without going into a detailed discussion of some of the problems encountered when trying to use Schaeffer's immense, and partly speculative system in practical analysis of electroacoustic music (or of bird song, or of ethnic music), let us briefly summarise the reasoning behind the proposed revision of Schaeffer's original design.

[2]A specially designed font, called 'Sonova', has been used to produce the graphic signs used in the diagrams.

[3]Roy goes on to discuss criteria for dividing a piece into units, applying explicit criteria defined by principles taken from Gestalt Theory, in combination with the paradigmatic method developed by N. Ruwet. In this respect his approach is exemplary in its explicitness. He ends up with a little more than forty functions designed to characterise the relationships between the sounds. However, since this article only deals with the primary level of sound objects, it would not be relevant to carry on with a detailed comparison of the two methods.

[4]*Formules Typologiques* (Schaeffer 1966: 466–7).

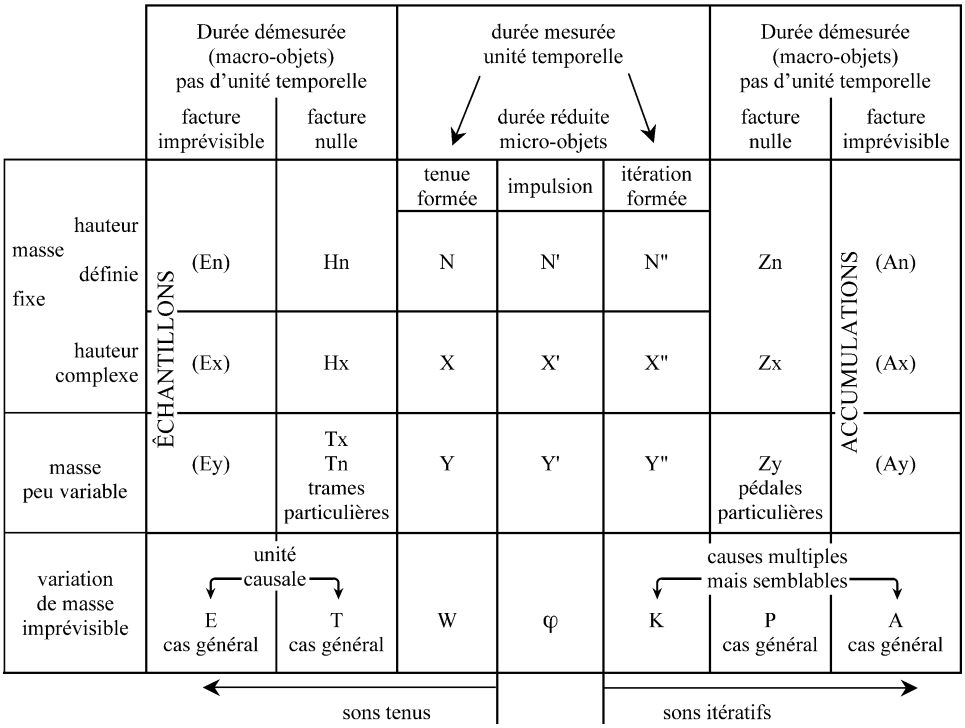

Figure 1. TARTYP.

The most important feature of this revision is the introduction of graphic symbols as opposed to letters or verbal designations to represent the analysis. This opens a number of new possibilities. Graphic symbols make a multidimensional representation possible. Considerations of typology and morphology may enter into an integrated, compact representation of the sound object. The disadvantage of using letters, as Schaeffer did, is that they only lend themselves to the formation of strings of arbitrary symbols, whereas graphic symbols can be combined and also used to give iconic representations of the sonic dimensions such as pitch/register, durations, and the superposition of simultaneous elements. Graphic symbols can be drawn in detailed ways that eliminate the need for a number of diagrammatic categories (e.g. all categories dealing with melodic profiles can be simply drawn, as can many aspects of duration, pitch and register).

The introduction of a graphic notation calls for a re-examination of the need to maintain all twenty-eight categories of TARTYP; the present approach starts by reducing it to its cardinal points. Moreover, the normative dimension of TARTYP, i.e. the distinction between *suitable* objects (*objets convenables*) and *unsuitable* ones (*objets trop originaux, objets trop redondantes*) is removed. Accordingly, the distinction between '*facture*' and '*entretien*', which also implied a qualitative evaluation of sounds, is removed as well.[5] Considerations of duration were removed from the diagram, with the exception of the point zero of the energy axis, which had to be maintained. Categories of duration were then reintroduced by a subsidiary graphic notation that can be added to the core symbols whenever desirable. Accordingly, the 'redundant objects' were removed from the diagram altogether.

What now remains on the horizontal axis, that of the energy articulation, is the logical line of moving from a short impulse, via medium durations with simple objects towards increasingly complex, ultimately unpredictable objects. In keeping with Schaeffer's original design, this happens symmetrically from the middle.

On the vertical axis, the same basic distinctions are preserved: pitched, complex (i.e. unpitched) and variable sound spectra. We now have a minimal representation of TARTYP, consisting of the nine central categories, as well as the two times three categories on the extreme left and right, i.e. altogether fifteen cardinal cases. What needs to be done next is to fill the voids between the inner nine and outer six categories with transitional objects. Once the diagram is reconstructed, we will also see how the Schaefferian objects that were removed can be regained, through the use of the graphic tools, and listed as special cases.

The graphic symbolism developed is very well suited for a digital representation. Andreas Hedman, a Swedish composer associated with the EMS in Stockholm, has produced a font that contains all the

[5] '*Facture* is not a neutral term like *entretien*. It is qualitative and implies that certain sound types are more likely to have musical potential than others due to their pitch content and dynamic shapes. Thus all sounds have *entretien*, only some have *facture*' (Dack 1998: 88).

elements needed to draw the standard symbols in a simple text file.

2.1. Listening intentions and questions of pertinence

The Schaefferian project has made it eminently clear that a person's aural perception of any object is founded in one among many possible listening intentions. Thus, there is an adequate listening intention corresponding to each pertinent feature of the musical discourse. Any verbal exchange about music as heard will tend to become incongruent, even meaningless, unless there is consensus regarding listening intentions and their correlation to a stratum of pertinent sonic information. The question of pertinence is, of course, delicate and somewhat controversial when it comes to the aesthetic appreciation of electroacoustic music (Delalande 1998). On the other hand, it can be said that the lack of any conventions with regard to discussing and analysing electroacoustic music is detrimental both to pedagogy, humanistic research, and possibly also to public comprehension and acceptance of this novel art form.

The present article presents a set of analytical conventions that presuppose the practice of a *reductive listening*. This intention is characterised by the *intention to hear the sound simply as a sound*, mentally bracketing its indexical associations (ideas about the sound source), as well as its traditional position in pre-existing musical languages, and refraining from any other interpretation of symbolic or semantic nature. Michel Chion summarises the Schaefferian thoughts on the subject succinctly:

> The reductive listening is a listening attitude that consists in listening to the sound itself, as a sound object, while abstracting it from its real or supposed cause, as well as from the meaning it might convey. More precisely, it consists in turning this double curiosity for causes and meanings (both of which treat the sound as an intermediary between other objects towards which it directs the attention) towards the sound object itself … (Chion 1983: 33)

This is a listening intention that easily can be taught and shared, and is thus fit for providing one intersubjective basis of observation. Complementary intentions may and should of course be developed; I myself have for instance been carrying out research on the aural constitution of structure, in a post-Schaefferian spirit for many years (see References). The method of analysis presented here is designed in such a way that it can be integrated into the still broader context of graphical, analytical tools for describing aural thought.

Mastering the intentionality of open reductive listening is a first step that leads to careful observation of the different attributes of the sound as such. It soon becomes evident that the traditional terminology of Western music theory does not contain the vocabulary to discuss the emergent qualities of the sound objects. Schaeffer's typomorphology comes as a result of an activity of *predication*: names have been assigned to a number of different sound qualities, and a number of different criteria of listener dimensions in single sounds have been systematised. When sounds are listened to with the purpose of placing them into a pre-existing category, the *openness* of the reductive listening is easily lost in favour of a more *selective attention*. Very quickly we may impose conceptual prejudices on perceptual givens. This may be an inevitable disadvantage of any attempt to codify aural phenomena. However, once one is made conscious of it, one can choose whether to practice the open reductive listening or the categorising reductive listening. Each of these attitudes are valuable in their own right: the open reductive listening tending towards the Husserlian *epoché* can often lead to the discovery of new aspects of an object and lead further on towards the creation of new musical ideas. However, many observations in this realm of thought will be impossible to communicate through words, and this is where some shared, conceptual conventions will be of use.

Reductive listening goes well with the 'taxonomical' approach to listening, i.e. listening to the way the music is ordered (what are the units the piece falls into? What are their relationships? etc.) Neither of these are spontaneous, 'layman' ways of listening. However, to a musician and a composer, it is a necessary and required professional capability to master these listening intentions.[6]

We shall now discuss in more detail the reorganisation of Schaeffer's typological and morphologic concepts, not so much to question their validity, but rather with a view to their feasibility as practical tools of one particular brand of aural analysis, termed spectromorphological analysis.[7]

[6] In his above-mentioned article on music analysis and reception behaviours, Francois Delalande outlines a few listening behaviours. Taxonomic Listening, Empathetic Listening, Figurativisation feature prominently in his article; in addition he proposes 'Search of a Law of Organization', 'Immersed Listening', and 'Non-listening'. Denis Smalley points to the possible dangers of too much emphasis on reductive listening. '… It is as dangerous as it is useful for two reasons. Firstly, once one has discovered an aural interest in the more detailed spectromorphological features, it becomes very difficult to restore the extrinsic threads to their rightful place. Secondly, microscopic perceptual scanning tends to highlight less pertinent, low-level, intrinsic detail such that the composer-listener can easily focus too much on background at the expense of foreground. Therefore, while the focal changes permitted by repetition have the advantage of encouraging deeper exploration, they also cause perceptual distortions. My experience of teaching composers has often revealed to me that such distortions are frequent' (Smalley 1997: 11).

[7] The analysis of sound based on reductive listening is that aspect of musical analysis that best would render itself for an automatic analysis: a computer might analyse the physical aspect of sound and link the result of the analysis up against an interpretation into spectromorphological categories. Although this could be useful, e.g. in case one needs a rough score, the overall objective of the process of analysis, in our context, is the training of the aural consciousness itself. The repeated listening to the sound and the effort to determine its characteristics bring about a clearer aural awareness of the anatomy of different sounds. The resulting interiorisation of sonic qualities and their orientation in an overall conceptual structure is a prerequisite for an intuitive, creative mental process.

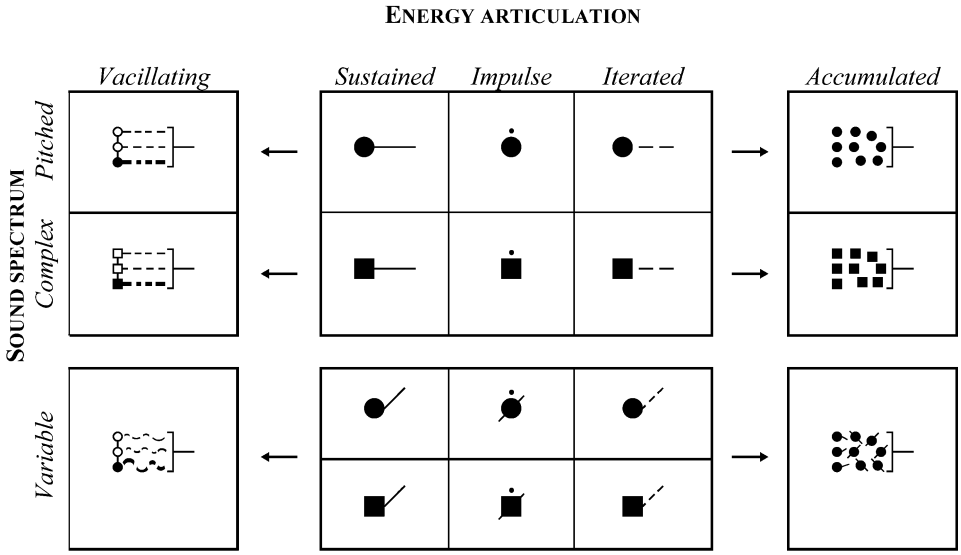

Figure 2. Typology – minimal representation.

3. DETAILED PRESENTATION OF THE REVISED TYPOLOGY

The minimal representation of the typology (Figure 2) shows only cardinal cases – the extremities of the organising axes – that later on will serve to orient the expanded version of the scheme. The vertical axis sets up three criteria of the sound spectrum (left hand side), the horizontal axis deals with that of *energy articulation*.

The criterion *sound spectrum* is a definition of that aspect of the sound in which the perception of pitch and pitch content is founded. The sounds that have a clearly perceivable pitch or fundamental will be termed *pitched sound objects* (*sons toniques*). The ones with no perceivable fundamental (drum sounds, tam-tam sounds, wind, consonants, etc.) will be termed *complex* or *unpitched sound objects* (*sons complexes*). Sound objects with a gradual internal development in its sound spectrum (glissandi or sounds with gliding formants) will be termed *variable sound objects* (*sons variés*). These may be either pitched or unpitched.

Beginning with the *impulse* (short thrust of energy) and moving to the left, the impulse is prolonged and comes to form *sustained* objects. Towards the right, the object is prolonged by means of *iteration*, i.e. quick repetitions as in a tremolando. On the extreme left of the diagram we find sound objects that, although basically sustained or continuous in energy, have an unpredictably diversified energy articulation, and could accordingly be termed *vacillating sound objects* (the English term is not a translation of the French *echantillon* [lit. 'Sample']). The creaking of a door, the cracking of the tone produced by a badly handled bow on a string instrument are examples of vacillating sounds.

On the extreme right we find sound objects called *accumulations*. They are thought of as being over-articulated iterations; i.e. iterations in which the iteration pulse as well as the sound spectrum of the single occurrences are unpredictable in detail. Examples of these objects would be the sound of raindrops on a tin roof, the sound of a flock of sparrows, or of peas running out of a bag and hitting a table.

Interestingly, the extremes of the diagram meet: vacillating sound objects and accumulations can be very similar. Both of the types of sound objects can combine pitched and complex sonic elements. One could speak of *homogenous accumulations* (using only one type of sound) as opposed to *heterogeneous accumulations* (mixing different types of sound, particularly those with different characteristics of sound spectrum). A similar distinction can be made with regard to vacillating sound objects.

3.1. The expanded typological diagram

In the simplified diagram two blank columns were left open for transitional categories after we removed the two categories of macro objects. In the expanded diagram some additional categories are introduced (Figure 3). Between pitched and complex sounds a category termed *dystonic sound objects* (corresponding to Pierre Schaeffer's *sons cannelé*) is inserted (Chion 1983: 146–8). These are ambiguous sounds whose sound spectrum is formed by a mixture of pitched elements and clusters. Instruments like gongs, triangles, and bells fall into this category.

All objects listed in the central three columns have been doubled: there are both filled and empty note heads.

- The empty, round note heads will be used for sinusoidal sound objects (*sons purs*).

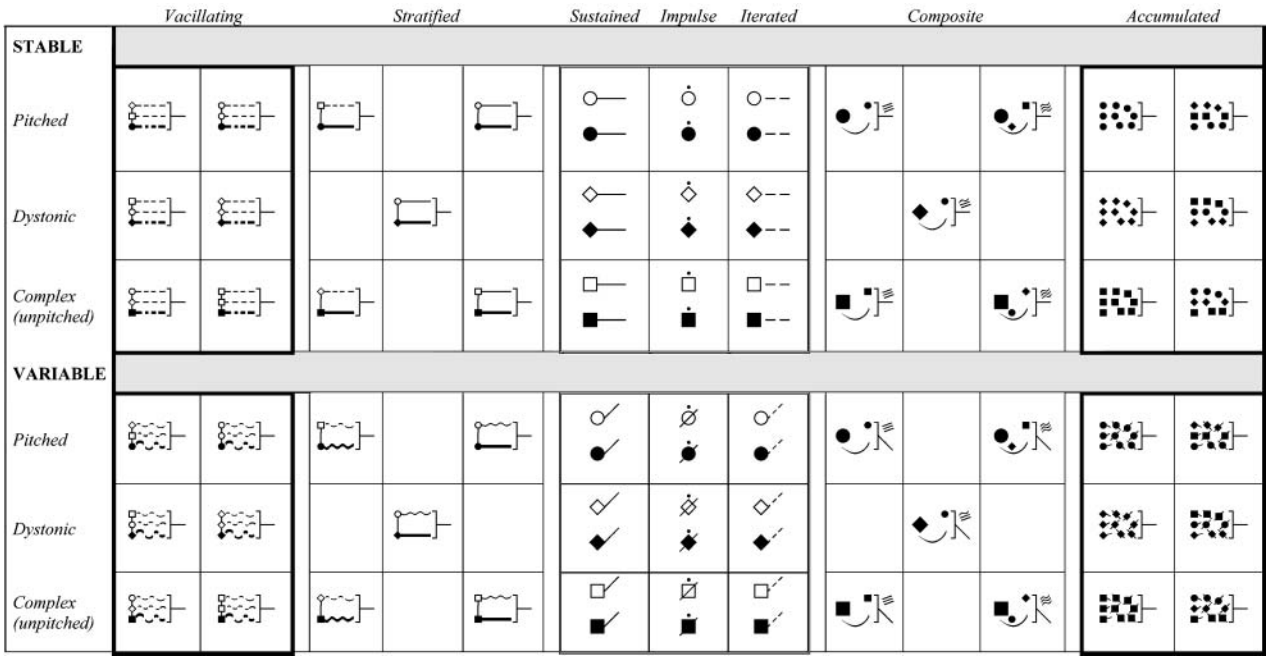

Figure 3. Typology – expanded diagram.

- The open diamonds will be used for whisper-like, quasi-pitched sounds.
- Empty square note heads will be used for 'unvoiced' complex sound objects (thus hhh-sounds, broad bandwidths of white noise, etc., as opposed to a filled square for drum sounds, clicks etc.).

The intermediary category placed in the column on the right diagrammatic axis will be termed *composite sound objects* (these would correspond to a Schaefferian category in his 'external morphology', called *composé*, i.e. distinct and successive elements; Schaeffer 1966a: 464–6; Chion 1983: 140). This category contains several subcategories, moving from relatively simple cases towards increasingly complicated objects. The simpler cases would, for example, consist of a pair of sounds, such as a grace note added to (or inserted into) a main note, or a trill or mordent. Moving towards greater unpredictability, we can add more notes, let them be more diversified in sound spectrum, and/or let the iteration pulse become increasingly irregular. I see no reason to create a detailed conceptual structure containing various subcategories of composite objects, as the character of the composite object in question will be adequately rendered by an appropriate combination of graphic symbols. However, the need arises for a notational tool to describe degrees of irregularity, and such a tool will be presented shortly.

The open void on the left side of the diagram is filled with sounds called *stratified objects* (these would correspond to a Schaefferian category in his 'external morphology' called *composite*, i.e. objects with distinct and simultaneous elements; Schaeffer 1966a: 464–6; Chion 1983: 140). These are sustained sounds that show different degrees of internal differentiation. The simplest case is a sustained sound with a prominent harmonic. From there on we proceed to increased spectral differentiation, inclusion of elements of contrasting sound spectrum, eventually spectral fluctuations with increasingly irregular pulse, until we arrive at the vacillating object. As was the case with the other intermediary category, the exact nature of the object may be shown through the graphic notation.

4. TYPOLOGIES OF DURATION AND OF REGULARITY

As the consideration of duration was removed from Schaeffer's original design, and the concept of a gradual transition between different degrees of regularity was introduced into the intermediary categories, some additional signs and definitions will be needed. I have earlier worked out an analysis of 'types of velocities', features of which will now be selected for inclusion in the spectromorphological analysis.

4.1. Types of velocity and duration

- *Gesture time*. The central category of velocity/duration is equivalent to the duration's characteristic of Schaeffer's *tenues formés*. These are sounds long enough to have an onset phase, a sustained part and an ending, while short enough to be integrated aurally into strings of sounds that can be appreciated as a whole.

- *Ambient time*. To the category of very long/slow durations belong those sounds whose duration is so long that their sustained part dominates the opening and ending phases disproportionately. The durations of this category correspond to the duration of Schaeffer's *homogènes*. These are sounds that would make the aural comprehension of the relationship between more than two adjoining objects difficult as they cross beyond the retention/protention limits of immediate perception.
- *Flutter time*. When elements in a string of events run so fast that they tend to integrate or become blurred, we have reached the opposite end of the scale of velocities and durations. To the extent elements integrate, they become iterated objects, which is a case already covered in the typology diagram.
- *Ripple time*. Between flutter time and gesture time there is a transitional region, consisting of medium fast strings of sound objects discernible one by one, but tending to merge easily. In relation to a basic pulse in gesture time, ripple time forms the upbeats.

4.2. Pulse categories

Under pulse categories we will deal with phenomena such as regularity/irregularity, tendential changes of speed, etc. For the purpose of brevity, we shall confine this discussion to the main cases, all of which are first of all applicable to pulses of gesture time and ripple time. We discern three degrees of periodicity:

- *Regular pulse* divides time into equally long segments, or in equal number multiples of segments.
- *Irregular pulse* divides time into unpredictable durations.
- *Oblique pulse* forms an intermediary category between the former two. It may be based on duration ratios like 3:2, 5:3, or come about through the superposition of regular pulses.

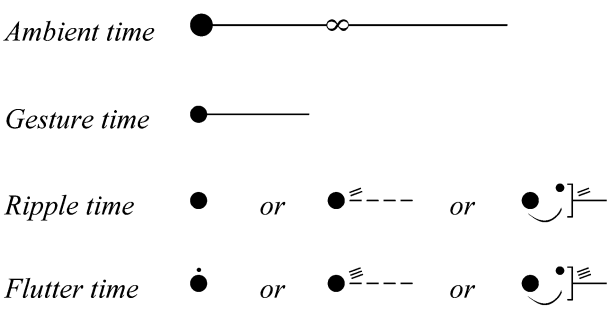

Figure 4. Types of velocity and duration.

Moreover, pulses may also change *tendentially*, i.e. through accelerandi and ritardandi. The tendential changes of time have been combined with indications of the three degrees of periodicity into tremolando-like graphic signs.

5. SPECIAL CASES

A number of cases that Schaeffer originally included in his TARTYP have temporarily been excluded from the central diagrams. Now, however, they can easily be regained by combining already defined graphic symbols. These are special case objects that can be named and listed, but have not been assigned single, specific graphic signs:

- *Sound web* (*trame*): an object in ambient time with constantly changing spectrum. A special case of stratified sounds.
- *Large note* (*grosse note*): an object in slow gesture time with a slowly and predictably evolving spectrum. A special case of stratified sounds with variable sound spectrum.
- *Ostinato* (*pedal*): a repeated sequence of sonic objects, ostinato-like. A special case of composite sound objects.
- *Cell* (*cellule*): an accumulation with a total duration in the range of gesture time.
- *Incidents*: a special case of composite objects.
- *Accidents*: a special case of stratified objects.
- *Homogenous sound* (*homogène*): a sound object with stable sound spectrum, without evolution in energy articulation, and of ambient time duration.

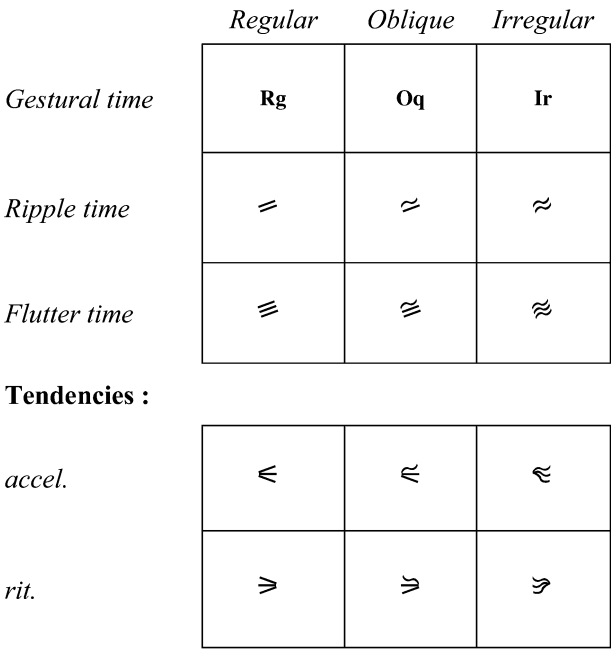

Figure 5. Pulse categories.

- *Fragment*: an extremely short sound. Can be notated by using the sign for the impulse half size.
- *Chord*: a superposition of several sound objects of similar kind.
- Additionally, the vacillating sound objects in gesture time, a case not incorporated in TARTYP, can easily be represented by the graphic tools.

6. MORPHOLOGY

Whereas the typology tried to sort out basic types of sound and separate them one from the other, we will now present more detailed criteria for how the anatomy of a single sound can be described. In doing so, we have taken a selection from Schaeffer's prolific TARSOM in order to make a workable tool for practical analysis.

6.1. Criterion: sound spectrum

- *Spectral width* (*classes de texture de masse*) (Chion 1983: 146). The width of the spectrum is defined in relationship to the extremities of sinusoidal sounds and white noise (Figure 7). The diagram begins with the sinusoidal shape, and then goes to the pitched sound with an overtone spectrum, especially a harmonic one. The diagram then bifurcates, suggesting that the intermediary stages to obtain a dystonic sound could pass through either a chord of pitched sounds (with a suitable interval structure that the notation does not specify) or through a further saturation of the spectrum. This logic is now followed further, to suggest the transition between dystonic and complex sound.
- *Spectral brightness*. An analysis of this dimension is actually not included in Schaeffer's typomorphology. The phenomenon is, however, well known from linguistics: the vowel sound [i] is considered brighter than [u] and intermediary cases can easily be conceived. A similar scale can be made for the complex impulse sounds of language: [t] is, for example, brighter than [d] or [g]. The characterisation of spectral brightness may, for instance, be important for discerning the colour difference between different instruments that all produce pitched sound objects. The graphic notation will vary according to the stability or variability of the sound in question: for stable brightness one sign will be used; for continuously varying brightness, a sign characteristic of stratified, variable sounds will be used.

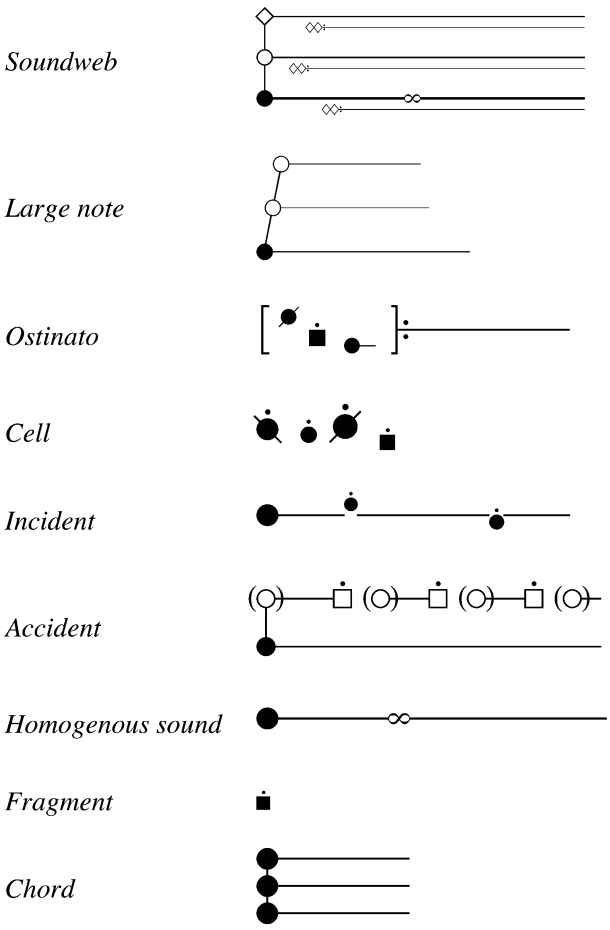

Figure 6. Schaefferian special cases.

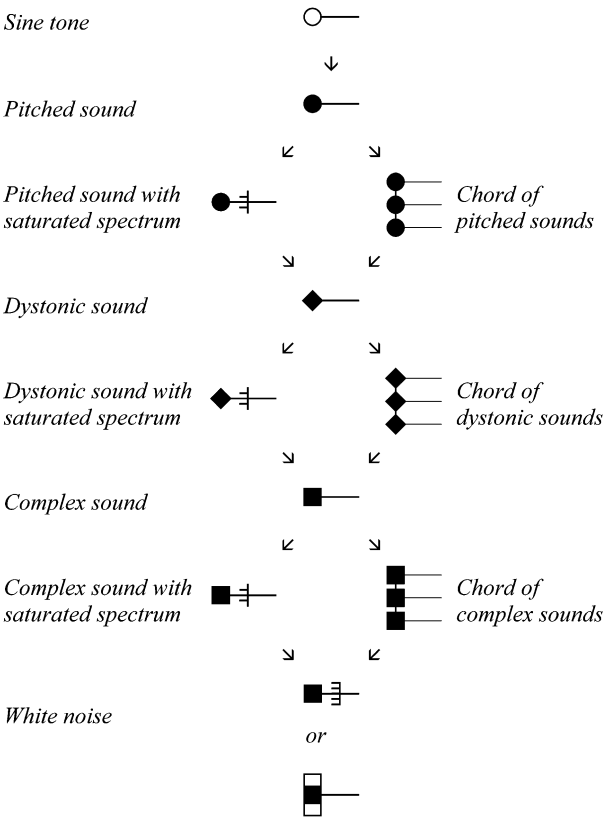

Figure 7. Spectral width.

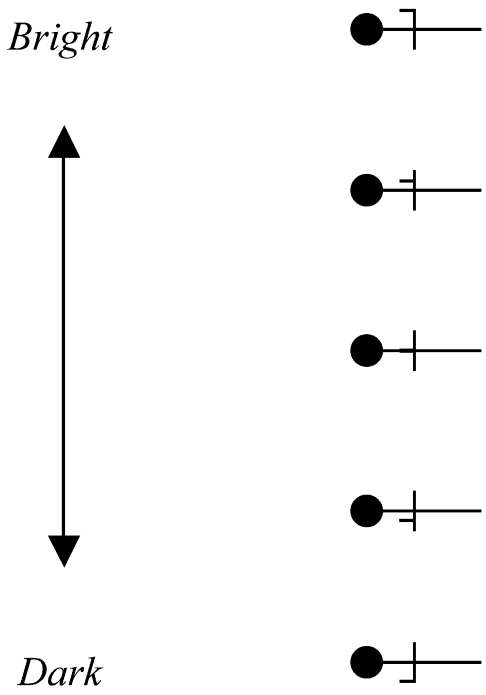

Figure 8. Spectral brightness.

The vertical line put on the prolongation line indicates the entire spectrum from high to low. The small vertical line on the left indicates the brightness of the spectrum, from high to low. The vertical line is ideally conceived of as absolute, so that, for example, its lower region is always the bass region, irrespective of the register of the pitch to which this particular colour is predicated.

For sounds with variable brightness, the notation of stratified sounds will generally be preferred. When the open note head is put in parenthesis, it indicates that the corresponding partial is not perceived as a separate pitch or entity, but is an integral property of the sound spectrum (its 'formant' in acoustical terms). *Spectral profile* will be the term used for the trajectory of internal variations in the width of the sound spectrum of the sound, e.g. the gradual transformation of a pitched sound to a complex sound. Internal changes in the width of the spectrum could be described as *expanding, convex, concave*, or *receding.*

6.2. Criterion: dynamic profile

The dynamic profile of a sound object is intimately connected to its energy articulation. Some of these profiles are already implied in the typology diagram, others are found in the list of special cases presented above. Schaeffer differentiates the following dynamic profiles:[8]

- *No dynamic profile* (*dynamique nulle*; no variation). Typical object: the homogenous sound – the static sound object in ambient time.

[8]See TARSOM, rubric 21; Chion (1983: 155).

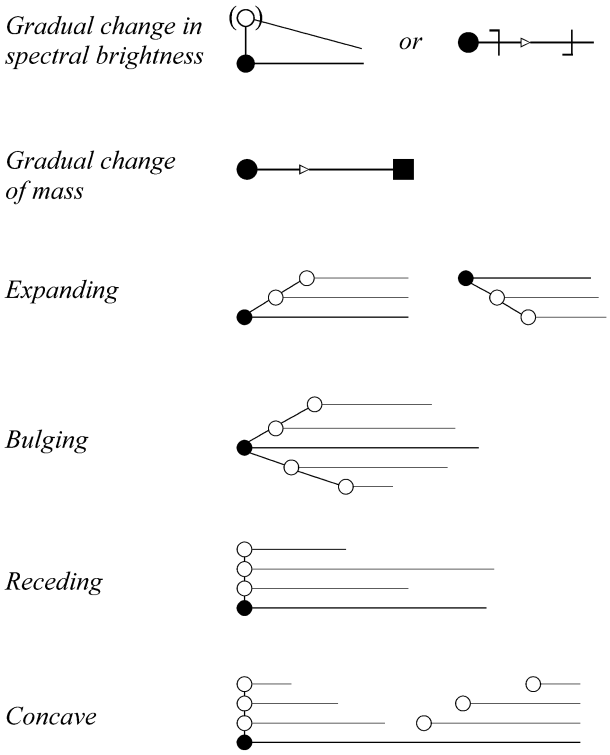

Figure 9. Spectral profile.

- *Weak dynamic profile* (*dynamique faible*; probably an undulation in slow gesture time with oblique, non-repetitive pulse). Typical object: sound web.
- *Formed dynamic profile* (*dynamique formée*; a profile in gesture time suggesting a beginning, middle and end). Typical object: the balanced objects in the two columns on each side of the middle one of Figure 1.
- *Impulse-like dynamic profile* (*dynamique-impulsion*; characterised by a sudden thrust and decline of energy, with no sustained phase). Typical object: impulse.
- *Cyclic dynamic profile* (*cyclique*; repetitive dynamics). Typical object: ostinato.
- *Vacillating dynamic profile* (*rëiteré*; irregular pulse in a continuous energy flow). Typical object: vacillating sound objects.
- *Accumulation-like dynamic profile* (*accumulé*; irregular pulse in a discontinuous energy flow). Typical object: accumulation.

There are dynamic profiles that are characteristic of certain timbres, namely sounds of the type attack-resonance. The attack or onset phase determines in fact the character and duration of the resonant phase of the sound. The ear is therefore particularly sensitive to the timbre information given in the onset phase, and uses this information to identify its timbre and its source. The information in the onset phase can be conceived of as a bundle containing a certain characteristic duration,

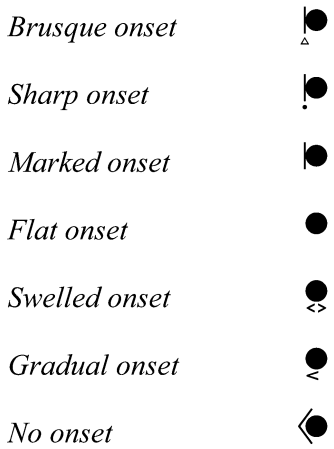

Figure 10. Dynamic profile.

articulation and sound spectrum. Figure 10 shows the proposal for onset phase genres; they differ in minor respects from those of Schaeffer (Chion 1983: 158):

- *Brusque onset*: e.g. a sound caused by a metal hammer stroke against metal; the attack transient is clearly and separately perceived.
- *Sharp onset*: e.g. a sound caused by a mallet or plectrum; the onset sound is closer to the character of the main body of the sound as opposed to the former case.
- *Marked onset*: normal (non legato) onset of a wind or string instrument.
- *Flat onset*: no particular marking of the onset as, for example, in legato playing.
- *Swelled onset*: a short crescendo/decrescendo.
- *Gradual onset*: the sound begins with a swell or a crescendo.
- *Without onset*: the onset cannot be heard – '*dal niente*'.

If desired, the onset can be further characterised by adding an indication of the spectral brightness of the opening transient (Figure 11).

A typology of onset phases ought to be complemented by a corresponding set of typical ways of ending a sound. Such a typology does not exist in Schaeffer's TOM, or in his Solfège. The reason may be that the beginning of a sound naturally attracts more attention than its ending; the opening phase of the sound often contains its structurally pertinent features. There are, however, cases where the way a sound ends can have musical pertinence (e.g. when resonating sounds are contrasted with sounds whose resonance is suddenly interrupted).

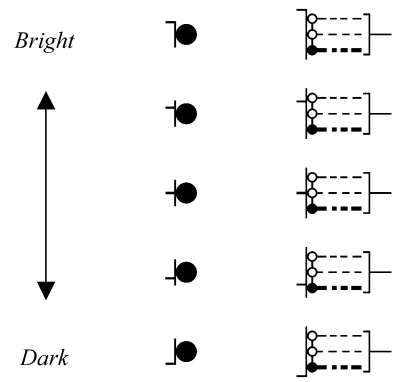

Figure 11. Spectral brightness of the opening transient.

Figure 12a shows the proposal for a typology of ending genres. Since the ending of a sound generally may be left unspecified, the majority of these categories will concern sounds with a clearly audible ending transient. It should also be pointed out that in the case of *impulses*, there will be no need to describe the ending phase at all. Thus the genres below will only deal with *prolonged* sounds, either *sustained* or *iterated*. Moreover, we have left out endings that are voluntarily imposed on the sound, as they can conveniently be designated through conventional dynamic signs.

- *Abrupt* ending: sounds with an accentuated ending phase, containing elements alien to the main body of the sound; e.g. vibrating string dampened with metal rod.
- *Sharp* ending: sounds with an ending phase containing elements intrinsic to the main body of sound itself; e.g. harpsichord tone.
- *Marked* ending: sounds stopped suddenly, rather than rounded off.
- *Flat* ending: unmarked.
- *Soft* ending: the ending of the sustained sound is rounded off with a diminuendo.
- *Resonating* ending: a resonating sound is let free to resonate until it dies out; '*laissez vibrer*'.

The sign for resonance will be a slur. The slur can be combined with a prolongation line; the latter will then indicate the length of the sound (e.g. bell sound that vibrates after the attack). When the slur is added after the prolongation line, it will either mean a *laissez vibrer*, or simply suggest that the sound has a reverberation, and that the duration of the sound is not indicated precisely by the prolongation line. The case of marked damping of a resonating body, the interrupted resonance, is an important special case.

Abrupt, sharp or marked endings will occasionally be reinforced by a crescendo, giving amongst others the case of the reversed sound (e.g. a vibraphone sound replayed backwards) (Figure 12b).

6.3. Criterion: gait

The term *gait* is an attempted translation of the French word *allure*, meaning *a way to walk*. The English term 'allure' is unsuitable as a translation of the French word, as it means 'to entice by charm or attraction' (*Infopedia Dictionary*). The word gait seems to render the French

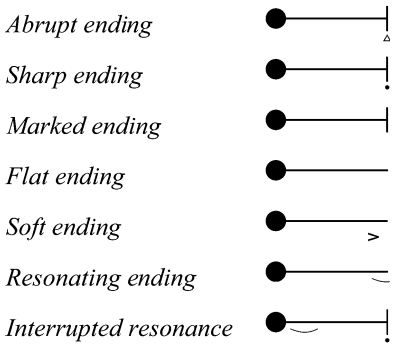

Figure 12a. Ending genres.

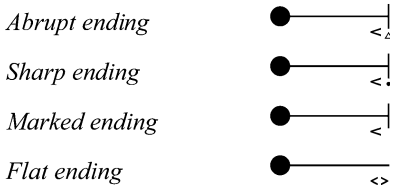

Figure 12b. Ending genres.

better, as it means: 'a manner of walking or moving on foot; a sequence of foot movements (as a walk, trot, pace, or canter) by which a horse or a dog moves forward' (*Infopedia Dictionary*)

The gait of a sound object is the undulating movement or characteristic fluctuation that often can be found in the sustained part of sound objects. The gait of a sound could be defined as being the idea of a vibrato generalised (Chion 1983: 158). These undulating movements can be traced in the pitch dimension, in the dynamic dimension or in the spectrum of the sound object. Thus we will distinguish between *pitch gait, dynamic gait*, and *spectral gait*.

The gait will be further analysed with regard to its degree of *deviation* (i.e. the degree of its departure from an average value) and its *pulse velocity* (which will generally range from gesture time to ripple time; in order to specify the latter we will add the tremolando-like signs shown in Figure 5 over the prolongation line of the gait sign). The design of the diagram is meant to emphasise the five cardinal cases (extremes and middle position) – these would often be sufficient for practical purposes.

Sometimes, the analyst will be faced with the choice of whether to represent what he or she hears as an undulating glissando (using the main prolongation line of the sound) or a slow and wide pitch gait. Generally, gait is perceived to be more 'ornamental' than a glissando; a secondary, perhaps expressive musical element, rather than a line with its intrinsic importance for the musical discourse. The gait of a sound can be seen as the 'signature' of its source. The person behind the voice, the individual player behind the violin tone can be identified by the characteristic way in which the

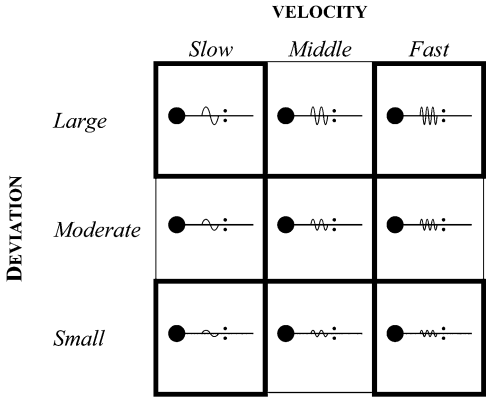

Figure 13a. Pitch gait.

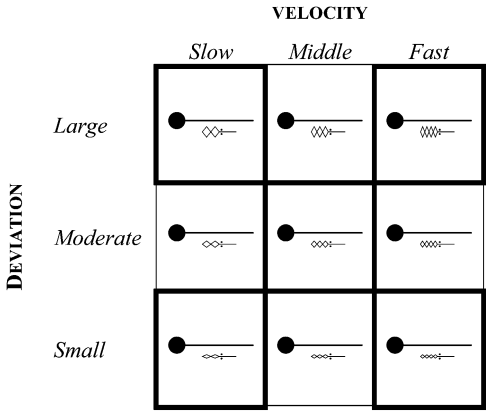

Figure 13b. Dynamic gait.

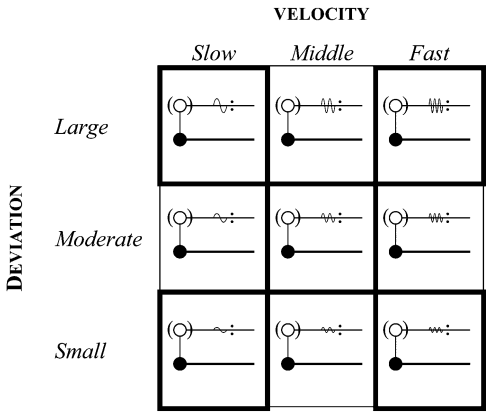

Figure 13c. Spectral gait.

sound is vibrating. If one generalises all sound sources to three overall categories, namely living ones (pre-eminently human), natural ones (i.e. phenomena of nature), and mechanical ones (i.e. produced by machines), it would appear that living sources have a tendency to vibrate in a slightly oblique pulse, the natural ones in an irregular pulse, and the mechanical ones in a regular pulse (Chion 1983: 159).

6.4. Criterion: granularity

The microstructure of a sound object can be more or less *coarse* or *slick*. The consideration of this aspect of the sound will fall under the category of *granularity*. It is a dimension of sound comparable to the abrasiveness one can feel when touching a piece of cloth or a mineral, or the granular quality one can discern in a photograph. Granularity, then, can be perceived through three sense modalities: sight, touch and hearing. For all of these fields it can be described in the same way, i.e. as the overall perception of irregularities of detail ('grains') that affect the surface of the object (Chion 1983: 152).

However, sometimes the distinction between granularity and iteration can be hard to differentiate when conducting an analysis. Generally, grains are a micro feature of the object in question, whereas iterations are of a coarser kind; thus grains would tend to be smaller, quicker, and be inseparable from the main body of the sound. A subsidiary consideration would be to regard the *idea* of the cause of the grains; this is a slight aberration with regards to the reductive listening, but nevertheless one which Pierre Schaeffer himself proposed when suggesting a typology of grains that distinguished between grains resulting from beating (such as the grains of the deep notes of the double bassoon), rubbing (as when the violinist increases the pressure of his bow), and resonance (such as the myriads of small particles that can be imagined to exist in the sound of a cymbal) (Schaeffer 1966a: 152–4; Chion 1983: 551–5).

A simplified representation of Schaeffer's many distinctions of granularity is shown in Figure 14a. The coordinates of the diagram are *Coarseness of the grains*, and its *velocity*, which in all cases would be in the region of quick flutter time. A further analysis of the phenomenon of granularity would look into:

- *the sound spectrum of the grain* (to the extent it differs from the sound spectrum of the 'carrier' sound),
- *the weight of the grain* (how prominent the grain is in relation to the 'carrier' sound), and
- *the placement of the grain* (i.e. in which register the grain can be found).

Figure 14b shows the graphic notation of the latter categories.

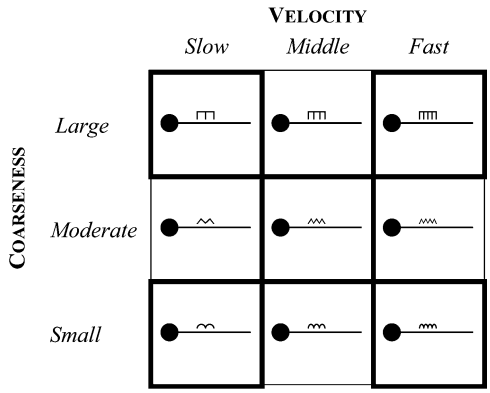

Figure 14a. Granularity.

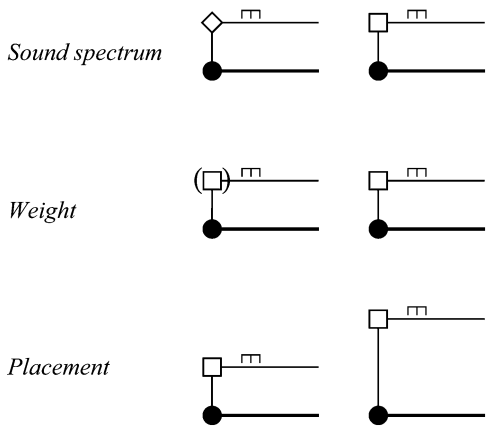

Figure 14b. Granularity: spectrum, weight, placement.

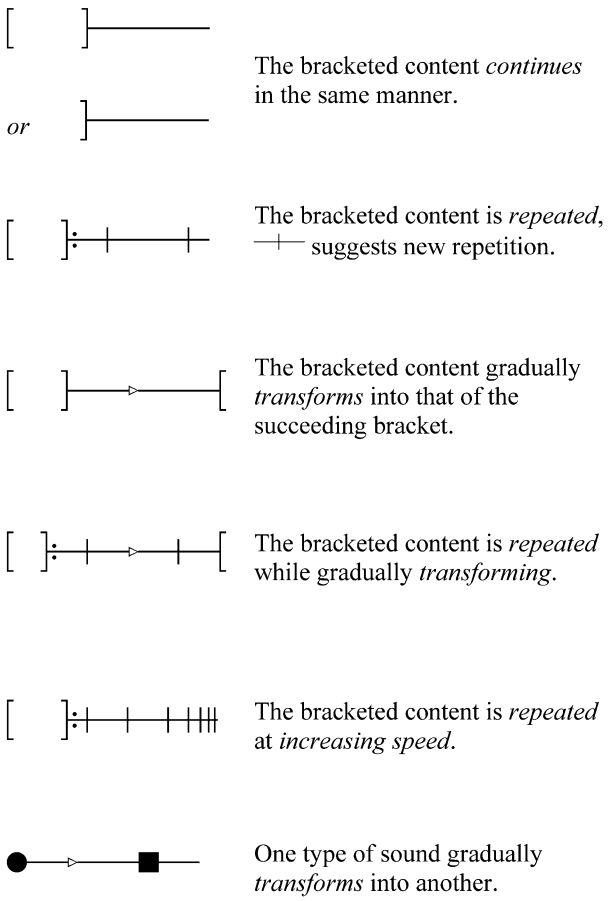

Figure 15. General additional conventions of notation.

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