At the limits of Schaeffer's TARTYP

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Abstract

Schaefferian typology and morphology are the first two stages of his *Programme de la Recherche Musicale* and comprise a taxonomic system of classifying and describing sound objects according to the 'primacy of the ear' rather than causal origins. I intend to investigate sound objects situated at the extreme limits of Schaeffer's *Tableau Récapitulatif de la Typologie* (TARTYP). These types are characterised by their excessive durations and/or the complex behaviour of their spectral components. Consequently, they subvert the behaviours of sounds from the 'real-world' and traditional instrumental sources. Nevertheless, such sound objects are often included in the musical vocabularies of many electroacoustic composers. For the analyst or composer, the ramifications of traversing TARTYP from the centre to the edges exemplify many problems confronting contemporary electroacoustic (and instrumental) music.

Keywords: Schaeffer, Typology, Morphology, TARTYP, excentric, redundant

1 Introduction

In the works of many electroacoustic composers the interaction between technology and music research is implicit. This is hardly surprising: the function of composers is to compose, theory can often be left to musicologists and analysts. However, in 1948 Pierre Schaeffer made the connection explicit. By assimilating aesthetic issues and technical developments as well as drawing on psychology, philosophy and acoustics he initiated a form of music research which continues to the present day. It is surely significant that the inheritors of Schaeffer's project bear the name *Groupe de Recherches Musicales*. A major preoccupation became how musicians can generate materials and, by extension, language from technical processes when supporting instrumental structures are absent. Pierre Schaeffer's rare combination of technical expertise and artistic sensibility made him aware that technology need not be restricted merely to recording and broadcasting sounds. These 'passive' roles can be transformed into a form of 'active' participation as composers attempt to discover the musical potential inherent in all aspects of sonic material. Whilst acknowledging traditional musical

languages, Schaeffer also realised that studio practice would inevitably produce new techniques and sound materials and these would demand new theoretical systems. Moreover, he believed that by a careful balance between these new practices and their theoretical ramifications, musicians would develop a more profound understanding of music - all music - as a social and artistic practice (1). Many of these ideas were presented in his *Traité des Objets Musicaux* (Schaeffer 1966). His deeply humanist attitude ensures that technology, however important, is never elevated above the sounds and our perception of them.

The years between Schaeffer's first experiments in 1948 and the publication of the *Traité des Objets Musicaux* is a particularly significant period. Schaeffer and his colleagues gradually became aware of the full implications of the new medium: sounds need no longer be restricted to a physical source even though the perceptual strategies of the listener might still use it as a point of reference. This liberation of sounds from sources was evident from the very first experiences in the studio. Consequently, there was an immediate connection between the technological means of sound realisation and resulting theory. For example, even the most 'primitive' techniques (by present-day standards) of the early musique concrète studio resulted in sounds whose dynamic behaviour and spectral constitution would not - in many cases, could not - refer directly to any known physical cause. Editing, changing playback speed, creating tape loops, adding reverberation and filtering confronted musicians with limitless numbers of new sounds. Schaeffer eventually devised a system of classification and description based solely on perception. My intention in this article is to examine the sound types identified by Schaeffer as existing on the fringes of traditional music. They are *excentric* sounds (sons excentriques) (2) and *redundant* sounds (sons redondants). I will examine his diagram, the *Tableau Récapitulatif de la Typologie* (or TARTYP) (3)

Fig. 1

Tableau récapitulatif de la typologie (TARTYP)

	disproportionate duration (macro-objects) of no temporal unity		measured duration temporal unity			disproportionate duration (macro-objects) of no temporal unity	
	unpredictable execution	non-existent execution		reduced duration micro-objects		non-existent execution	unpredictable execution
			formed sustainment	impulse	formed iteration		
definite pitch — fixed mass	(En)	Hn	N	N'	N''	Zn	(An)
complex pitch	(Ex)	Hx	X	X'	X''	Zx	(Ax)
not very variable mass	(Ey)	Tx Tn	Y	Y'	Y''	Zy	(Ay)
unpredictable variation of mass	E	T (web)	W (large note)	Φ [fragment]	K (cell)	P (ostinato)	A

SAMPLES (left column); ACCUMULATIONS (right column)

held sounds ← | → iterative sounds

which was published in the *Traité des Objects Musicaux* (Schaeffer 1966: 459). By contrasting the *balanced* sounds with those of *excentric* and *redundant* sounds their implications for different languages can be assessed.

2 *The Tableau Récapitulatif de la Typologie* (TARTYP)

TARTYP attempts to represent diagrammatically the entire sound universe. Sound types were isolated and classified according to the stages of typology and an initial stage of morphology (4). Types were then placed in boxes formed by the intersections of the diagram's horizontal and vertical axes. Schaeffer himself stressed that to assign a sound object exclusively to one type might occasionally be both difficult and inappropriate as, due to context, a sound object's classification might require reassessment. A careful examination of the diagram reveals the subtle intelligence of Schaeffer's theoretical approach. The formidable challenge facing him was the necessity of combining several sound criteria into two dimensions. Thus, the diagram had to include Schaefferian notions such as *mass*, *sustainment* and *execution*. For example, the vertical dimension subdivides *mass* (a generalised notion of pitch) into four principal categories. This is indicated on the left-hand side of TARTYP. A sound object's *mass* will be either clearly defined and stable in the pitch-field (for example, the notes of traditional instruments: the flute, violin, piano…) or it will consist of a complex spectrum (such as

cymbals, piano clusters…). In addition to these categories Schaeffer lists *mass* which varies slightly in the pitch-field and *mass* which varies within the sound object in an unpredictable manner. Thus, the axis does not simply list *mass* from high to low positions in the pitch-field, nor does it describe the occupation of the pitch-field from the sine-wave to white-noise. The concept of variation and change within sound objects is incorporated into TARTYP at the most fundamental stage. This is an obvious result of Schaeffer's preference for investigating concrete sounds which are often lively and unpredictable. Furthermore, it contrasts with the approach of composers in Cologne where, due to serial preoccupations, the need for perfectly stable sounds was, initially at least, a priority (5).

The horizontal axis deals not only with duration (the sounds become longer as they move from the centre) but the manner in which the sound's energy is maintained over time. This is either continuous ('held sounds' to the left) such as a sustained note on a wind or string instrument, or iterative ('iterative sounds' to the right) where the sound energy is maintained in close, repeated bursts (a tremolo, for example). Furthermore, the notion of *execution* is incorporated into the horizontal axis in order to construct the two outermost columns on each side. *Execution* is an explicitly qualitative notion. If a sound object's spectral components and dynamic evolution behave in a manner such that a listener can imagine a physical source and cause, then the sound object has *execution*. It must be emphasised that this is not restricted to sounds that do have real-world origins; the sound object might be entirely synthetic - the appraisal is achieved solely by perception. Thus, to have *execution* a sound object must give the impression of the way in which it could have been created. For example, if we imagine a recording of a single, mid-range note played by plucking a string on a guitar, or harp. Its duration would be neither excessively short nor long and the evolution of its spectral components would conform to our learned expectations of a plucked string's physical behaviour. Such a sound object would have *execution*. However, if the same sound object were transformed by time-stretching and selective filtering, the sound's *execution* might be less evident. Providing the duration remained within certain limits and the dynamic profile and spectral components continue to behave in a relatively 'natural' manner, *execution* would probably still be applicable. Nevertheless, additional transformations could disrupt this assessment. By modifying the abrupt attack into a gradual onset, extending the total duration and randomly attenuating or emphasising frequencies *execution* is removed. The long duration inhibits the listener's memory of how the sound was initiated and the random fluctuations of the spectra creates an impression of artificiality. The incorporation of *execution* in TARTYP is essential as, in a sense, it can be used as an indication of how distant a sound object is from real-world experience. Sound objects with *execution* assist our predisposition to seek for a cause and relate it to familiar acoustic events leading, perhaps, to the creation of sound families. Naturally, this is a process which continues throughout a musical work and may need extensive modification as the composer confirms or subverts our culturally acquired expectations.

A central position in TARTYP is given to the nine *balanced* sounds and a brief examination of them is necessary in order to contrast their musical functions with those of sounds at the periphery of the diagram. *Balanced* sounds comprise the vast majority of the traditional Western instrumental vocabulary. It is only in the twentieth century that this has been enlarged by extended techniques and unorthodox orchestration. A *balanced* sound, by definition, has *execution*. It is of medium duration and has an easily perceptible, well-formed dynamic shape. The exceptions - impulses - occupy TARTYP's central column. Strictly speaking, due to their short duration, impulses are *balanced* but 'non-formed' (see Chion 1983: 129). The majority of music before the twentieth century consisted of the three N type sounds (sounds which have clearly defined, stable pitch) with occasional contributions from X types (similar to N sounds but of complex pitch). Y sounds which vary slightly in the pitch-field are relatively recent additions to Western music. However, the inclusion of Y type sounds is in itself significant. Schaeffer did not feel inclined to differentiate between Y sounds of definite or complex pitch. They are placed in the row of slightly varying *mass* indicating that the characteristic of slight variation was the predominant categorical feature. Even a cursory inspection of TARTYP reveals that *balanced* sounds occupy only a portion of the sound universe. Their dominant position in music can, of course, be explained. N type sounds function effectively within tonal, modal and even serial systems as elements at the lowest level of structure and can be organised into units at higher structural levels. Nevertheless, the exclusion of all other sounds cannot be justified in electroacoustic music. In addition, it must be emphasised that each box contains a vast number of individual sound objects. Once assigned to a category, sounds would be subjected to further description according to morphology.

3 *Redundant* and *excentric* sound types

The sound objects in the outer regions of TARTYP are the principle subject of this article and are situated in the two columns on either side of the *balanced* sounds - for sounds with 'non-existent *execution*' and those with 'unpredictable *execution*'. In addition, three types should be included which are situated in the lowest row in the three columns of *balanced* sounds.

3.1 *Excentric* sounds

Excentric sounds are complex and unpredictable in terms of spectral and dynamic evolutions. With the exception of three 'general examples' they display little sense of causal unity due to their chaotic or missing *executions*. The three 'general examples' can be seen in the central section of TARTYP's lowest row and contain the following types: *large note* (W), *fragment* (Φ) and *cell* (K). As they are placed immediately beneath the *balanced* sounds their durations are not as extended as the types placed in columns to the left or right. The *large note* is a continuous, coherent, evolving sound of medium duration. The *fragment* has (as one would expect) a short duration but not as short as an impulse. Its *mass* is perceived as disordered and incoherent. Lastly, the *cell* is of medium duration and consists of a number of short, discrete component sounds. While it might not be described as truly

iterative its energetic momentum is fractured and discontinuous. Schaeffer cited examples of these sounds in traditional music. For example, he claimed a *large note* can be found in Bach's Toccata in D minor (Schaeffer 1966: 456). The logic and consistency of each individual note is subsumed into a coherent whole. Thus, such sounds could be considered larger, more distended versions of their *balanced* counterparts situated above.

The sound types in the boxes to either side are less familiar in instrumental terms (apart from the avant-garde repertory). The continuous *excentric* sounds in the column to the left are the *web* (T) and the *sample* (E). These two types demonstrate that the difference is not based solely on duration. It must be stressed that the *sample* is not necessarily longer than the *web* just because it is further to the left. At this position in the diagram the columns of 'non-existent *execution*' and 'unpredictable *execution*' might be thought of as overlaying each other in a three dimensional arrangement as *execution* qualifies duration. The *web* will display no *execution*. It will, like the *large note* consist of interwoven slowly developing, indistinct elements and, most importantly, it will be 'shapeless', revealing no clear sense of an imagined causal origin. By contrast, *execution* can be applied to the *sample* but it will be unpredictable and incoherent. Schaeffer suggested the clumsy bowing of a beginner on a stringed instrument as an example. As one hears the bow scraping the string the result is fractured and inconsistent. The listener is aware of the sound's fricative origins but it varies wildly. The discontinuous sound types in the columns to the right are the *ostinato* (P) and the *accumulation* (A). The *ostinato* is a repeated (thus iterative) series of *cells*. The *accumulation* is a prolonged sound object consisting of many shorter components. These are disordered and, unlike the *ostinato*, do not exhibit a clear repetitive pattern but, as they resemble each other, they are perceived globally as a compact agglomeration. More specific types of *samples* and *accumulations* were suggested by Schaeffer according to the behaviour of their spectral components. If these were less unpredictable and chaotic they might be placed in higher boxes in the same column. Thus, finer distinctions of mass cause the sound type to migrate upwards to rows of 'fixed *mass*' as one identifies tonic *samples* (En) and complex *samples* (Ex). Interestingly, according to Schaeffer, at the extreme edges of the diagram the sounds begin to resemble each other: 'So the extreme columns of our table meet up at their limits.' (Schaeffer 1966: 454).

3.2 Redundant sounds
Redundant sounds occupy the same columns of 'non-existent *execution*' as the aforementioned *excentric* sounds *web* and *ostinato*. Therefore, these types display predictable, regular, even banal dynamic and spectral evolutions. However, their higher position in TARTYP ensures their mass is either not very variable or it remains fixed in the pitch-field, thus differentiating them from *excentric* sounds. *Redundant* sound types have a more extended duration than their *balanced* counterparts (indicating that there is a link between *execution* and duration). Four main types can be identified: *homogeneous* sounds (Hn, Hx) and special cases of *webs* (Tx, Tn), *ostinati* (Zy) and *sirens*. According

to Schaeffer the lack of *execution* betrays their artificial origins. This stems from the fact that such sounds are unlikely to result from single sources - instrumental or otherwise. They can only be produced by careful instrumentation. As a result of their duration and lack of clearly defined form, the ear can focus on the development in *mass* in the cases of the *special webs* and special *ostinati* (by definition there would be no development in sounds higher in these columns). These sound types seem to be particularly problematic as their formlessness hinders unambiguous classification. For example, Schaeffer did not include the type called a special *siren* in TARTYP as he considered it an extended version of the varied *balanced* note Y. This is made clear in a table of *redundant* sounds in the *Traité des Objets Musicaux* (Schaeffer 1966: 451).

Fig. 2

Recapitulative table of redundant or not very original objects
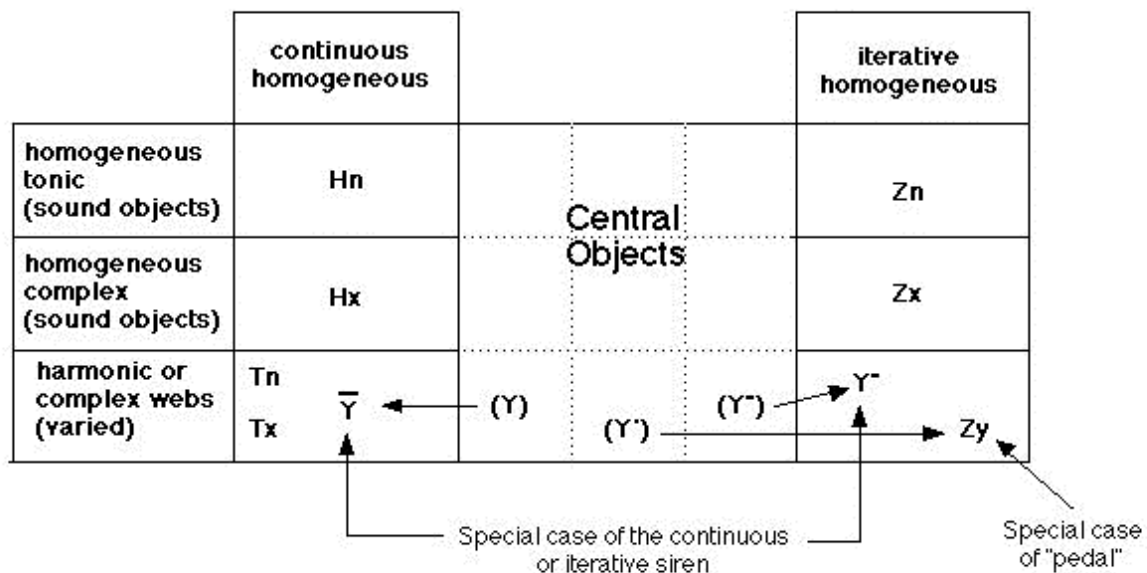
Traité des Objects Musicaux, 451

The diagram emphasises the flexible nature of classification; the edges of each box are 'fuzzy' rather than clear, rigid demarcations of types. Movement from one to another is always possible and context-dependent.

4 Implications for Languages
TARTYP's value would be limited were it to remain simply a taxonomy of sound types. Important though the stages of classification and description are, Schaeffer intended to investigate how sounds might function within a language. Consequently, he had to progress beyond the lowest level of musical discourse. Schaeffer considered, therefore, how structures are formed from sound objects. He wrote: 'We rediscover in a prosaic form the fundamental axiom: each structure is built on a variation,

but we are led to this discovery by two very different types of experience. The one discovers structure in a discontinuous configuration, a *series* of "musical" objects: the other notices it in the continuity of a *single* object.' (Schaeffer 1966: 562). Thus, two principal types of language could be proposed; their vocabularies consisting of either discontinuous or continuous sounds. (Naturally, these two languages represent the extreme poles of a continuum between which are many intermediate positions - music would be impoverished were this not the case.) Broadly speaking, discontinuous sounds are discrete sounds of short to medium duration. These are precisely the types which occupy the three columns of *balanced* sounds and the row immediately beneath them: the *large note*, *fragment* and *cell*. The principal way in which discontinuous sounds create structure is by giving rise to perceptible relationships between specific aspects abstracted from the totality of concrete features. This can be explained by the pairs value/characteristic (*valeur/caractère*) and permanence/variation. By combining these two dualisms into a network of relationships known as permanence of characteristics/variation of values (*permanence des caractères/variations des valeurs*) it follows that varying values can be perceived only if there is a sufficient number of characteristics which remain unchanged (or permanent). In traditional music, values are pitch and rhythm, characteristics such as dynamic level, articulation and all those remaining aspects are generally subsumed under the notion 'timbre' (6). The most obvious situation in which permanent characteristics are produced would be when sounds originate from the same source and according to a consistent manner of production. This happens, of course, when playing traditional instruments. The concept can be further illustrated by considering a familiar situation: the musicians of a string quartet, for example, will produce notes mainly by bowing (for sake of simplicity this example will exclude extended techniques which will, by definition, disrupt the permanence of characteristics and create a multi-instrument!). An amalgamation of sound features - harmonic spectrum, dynamic profile etc. - will result in a homogeneous family of N type sounds. These comprise the permanent characteristics: the instruments' 'timbre'. Against this consistent background the variations in pitches and rhythms - the values - will lead to the principle form-creating elements at all structural levels. Musical meaning results from the relationships between the discrete, discontinuous notes. Our capacity to hear pitch and rhythmic relationships is, in part cultural, but it is also based on cognitive predispositions. It is no surprise, therefore, that these are the two principal values of Western music and the instrument maker's goal is to ensure homogeneity of sound regardless of a particular note's register or dynamic level. In reality, of course, this model is simplistic. For example, aspects such as articulation and vibrato would not in themselves be classed as values. Poorly articulated notes and those without vibrato will exhibit pitch values and will not usually compromise the pitch-based discourse, but their roles in a satisfying performance are self-evident (7). Thus both values and characteristics are required. The model would be subverted by eliminating variations in pitch and changing the instrumentation. This promotes instrumental colour to the role of a varying value against permanent, unchanging pitch. The result would be Klangfarbenmelodie - a 'melody' of instrumental colour. The most important aspect of this model, therefore, is not so much a rigid distinction between specific

values and characteristics as Schaeffer's fundamental axiom itself. The notions of permanence and variation might be applied in a variety of ways and could fluctuate throughout the composition as values are established securely or ambiguously by the composer. Indeed, there are many examples where traditional characteristics have been transformed into values. For example, in 1958 Schaeffer composed 'Etude aux allures' in which variations in speed and depth of the morphological criterion *allure* - a generalised vibrato - were elevated into the principal structure-creating roles. The success or failure of such new discourses rests mainly on the listener's ability to hear 'abstract' relationships between these potential values. N type *balanced* sounds, due to their discontinuous nature and perceptible pitch contents, would be most suited to participation in such abstract musical languages while X and Y types would function less satisfactorily. Although the *large note*, *fragment* and *cell* are of medium duration, their disordered variation of mass might indicate that one of their principal roles would be to mediate between different types of discourse.

When applied to the acousmatic situation the physical existence of the instrument (or the sound-body in general) as sound source is redundant. However, Schaeffer coined the term 'pseudo-instrument' in recognition of our tendency to relate sounds to common origins if they displayed a sufficient number of common features. Thus, in an acousmatic work if sounds are grouped together such that the impression is created of a single source (whether real or not) then we have a pseudo-instrument. Consequently, sound families (or *genres* to use Schaeffer's term) can be created according to their immanent features. This extension of the traditional notion of instrument can still form the basis for the perception of values and characteristics. The consequences are profound. All instruments, due to the nature of physical systems, display varying degrees of unity due to the position of notes in the pitch-field, dynamic levels etc. The 'timbre' is seldom disrupted as the practised listener can, without difficulty, usually accommodate such inconsistencies. These subtle differences can, however, be exploited by the acousmatic composer who is able to mediate between different pseudo-instrumental registers leading to the creation of 'virtual' or 'hyper' instruments. The dualisms of permanence of characteristics/variation of values is not necessarily compromised, it is elaborated and extended.

It is the remaining sounds - continuous sounds - like the *redundant* and *excentric* types which must now be considered. Due to their length and variation in *mass* the dualism of value/characteristic would almost certainly be inapplicable. For example, if several *webs* occur in close proximity, could these be regarded collectively as a pseudo-instrumental genre? In addition, would they function in the same way as discontinuous sounds? Several *webs* might be juxtaposed with many common features. However, their duration and the development of internal variations would probably dominate over any attempt to perceive relationships between them based on pitch. There might be similarities between general profiles and behaviour of individual components in the *webs* but the listener would probably still be inclined to focus on the nature of the variation in *mass*. As Schaeffer asserted in the aforementioned quotation, structure could be perceived in the variation itself: 'in the continuity of a

single object'. For such sound-types Schaeffer suggested the pair of variation/texture (although this pair was not discussed in detail by Schaeffer). Continuous sounds as principal structural elements have no real precedents in traditional music and Schaeffer believed it was first necessary to create a repertoire in order to understand how these materials could be used - practice precedes theory. In addition, Schaeffer identified two different perceptual areas or fields relating to pitch and duration. Pitch has a 'harmonic' and a 'coloured' field. The former is applicable when sounds of definite pitch form relationships according to values and characteristics. The latter 'coloured' field is invoked when the sound objects are complex in spectrum or they vary in mass. It is in this 'coloured' field of pitch that *redundant* and *excentric* sounds would be most likely to function. Schaeffer also identified two areas of durations. A 'rhythmic' field which will tend to produce abstract relationships on the basis of values and characteristics as it concerns the perception of durations and distance between discrete objects. By contrast in the 'dynamic' field the ear would trace the variation's trajectory in dynamic profile or harmonic development over time. Schaeffer classified types of variation according to the speed and the density of information, these were then related to the variation's *execution*. Thus, a variation can be assigned to one of three types of *execution*. If the variation consists of minor fluctuations within an overall 'logical' process it is of the *fluctuation* type. If the variation is continuous and progressive it is an *evolution* type and if it is in discontinuous stages it will be a *modulation* type. These are associated with speeds ranging from slow through medium to quick to produce an approximate, but helpful, typology.

Languages which are based on continuous sounds and exploit the variations within the sounds were called "plastic" by Schaeffer to differentiate it from 'musical' languages based on discontinuous relationships. Another quotation illustrates this point succinctly: 'Let us imagine on the one hand a music using continuous or complex sounds. It offers glissandi or masses which are neither situated nor calibrated in the harmonic perceptive field. On the other hand, it enables the hearing of melodic or dynamic trajectories which did not exist before. This music has therefore chosen at both one and the same time other objects and other qualities of perception which we call "plastic". One could even imply that it gains its meaning where the preceding music lost its (meaning).' (Schaeffer 1966: 636). The concluding sentence summarises this situation perfectly.

Thus, *redundant* and *excentric* sounds can function as valid elements of musical discourse. The creation of tension and release at local and global structural levels can still be achieved as the listener is drawn into the sound and perceives how forward momentum or stability results from the composer's control of energy profiles and gestural qualities. Indeed, while the pseudo-instrument properly speaking is inapplicable to such sounds, characteristics can often still be related to natural phenomena or human activity involved in creating sounds; a pseudo-source is perhaps a more appropriate term (8). It is fascinating to read Schaeffer's account regarding the origins of music and how both the discontinuous and continuous can be related to real-world experiences. Chapter 1 of the

Traité des Objets Musicaux begins with his speculations on a primitive man 'playing' with gourds of various sizes and thereby discovering the 'instrument' and how permanence/variation functions. Towards the book's conclusion in chapter 33 he considers the same primitive man perceiving the wind and the sea and once again discovering musical structure, but this time in continuously varying sounds.

In conclusion, I would suggest that the importance of *excentric* and *redundant* sound types is essential to the electroacoustic medium. I do not wish to diminish the importance of explicit quotations from the real-world in electroacoustic works. The poetic nature of such sounds is unquestionable; they augment the vocabulary of electroacoustic music and can participate in a variety of languages. Nevertheless, I would argue that it is precisely when we are confronted with long, complex sound objects that the full implications of the electroacoustic medium are evident. These sounds have comprised a major part of many composer's music not simply because they are unusual but because it is in the electroacoustic medium where their musical nature can be discovered and exploited. If we seek a genuine electroacoustic "theory" (and I believe one is possible) there can be little doubt that these sounds will play a major role.

Notes
1) For a full account and evaluation of Schaeffer's achievements see: Dallet 1996.

2) I have adopted what might appear to be the idiosyncratic spelling *excentric* in preference to *eccentric* as this emphasises not only the strangeness of such sounds but their distance from the centre of Schaeffer's diagram. This spelling was used by Livia Bellagamba in the 1998 English translation of *Solfège de l'Objet Sonore*. For the sake of consistency I have also used her English terms for 'entretien' (sustainment) and 'facture' (execution). These are both problematic words when translated in English. Many issues raised in the translation of French terms are unresolved and at present there seems no general consensus. All Schaefferian terms have been italicised. In addition, there are several examples of the sound types under discussion derived not only from concrete and electronic sources but instruments.

3) I have slightly adapted TARTYP for the sake of this article. For clarification, the area of *excentric* sounds has been printed in grey. This emphasises its peripheral position. The area of *redundant* sounds is hatched. In addition, the English translations of individual sound types have been added in brackets and some arrows connecting boxes have been omitted. Readers are urged to refer to Schaeffer's original.

4) Morphology, properly speaking, was one of the five stages of the *Programme de la Recherche Musicale* (PROGREMU). Its role was the more detailed description of sound objects after their

typological classification. However, a preliminary description is clearly required to assign a sound object to a type.

5) Compare, for example, the diagram by Stroh of basic elements of the Cologne studio which illustrates the relationship between the sine-tones, white noise, Tongemische and Klänge (Stroh 1975: 13). In this diagram, duration is only implied by the inclusion of the impulse.

6) The term 'timbre' is a problematic notion and deserves a more detailed discussion which, unfortunately space does not allow. Schaeffer differentiated between timbre's original meaning as 'source' or 'origin' and the morphological criterion of *harmonic timbre*. In the present discussion I have used the term in its conventional sense.

7) An example of an excessive emphasis on values would be traditional music recorded with sequencing software. The pitches and rhythms will be accurate and the 'timbre' homogeneous. However, such recordings are invariably risible in musical terms precisely because the notes' articulation is too uniform. Even an average performer will shape notes according to phrasing and 'expression'.

8) For an excellent, thorough discussion of these issues see Smalley 1992 and 1997. In addition to the structural functions of sound types Smalley touches on the notions of real-world connections in his discussions of surrogacy and indicative fields.

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