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With the assistance of  
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**Lasse Thoresen:**

**Spectromorphological Analysis  
of Sound Objects**

**An adaptation of Pierre Schaeffer's  
Typomorphology.**

## Lasse Thoresen: Spectromorphological Analysis of Sound Objects.<sup>1</sup> An adaptation of Pierre Schaeffer's Typomorphology.

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* (meter). *Timbre* was traditionally regarded simply as a matter of colorization of musical structure, and was treated in terms of orchestration.

The electro-acoustic music, whose first breakthrough was the *Musique Concrète* of Pierre Schaeffer and Pierre Henry during the late 1940s, profoundly challenged the understanding of the nature 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 monopolize the discourse of electro-acoustic music. Pierre Schaeffer's "Traité des Objets Musicaux" (hereafter referred to as TOM) appeared in 1966. 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 20th Century musical thought.

Schaeffer's approach to the world of sound is characterized 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 State 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 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" (hereafter referred to as GOS). For the revisions of Schaeffer's ideas as well as the digitalization of the graphic signs I am grateful for the assistance of Andreas Hedman.<sup>2</sup>

### The adaptation of Schaeffer's typomorphology to practical analysis.

Schaeffer's ideas on the categorization of sound objects were summarized in TOM in the diagram called TARSOM. This was detailed into a number of other diagrammatic representations, of which TARTYP is the most important, as it is intended to present a presumably all encompassing typology of sound objects. (See Appendix 1). Schaeffer and Reibel later illustrated a number of these categories with sound examples in "Solfège des objets sonores". Letters are used to designate the different analytical categories of TARTYP.

<sup>1</sup> 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 schaeffériennes 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"." p. 183 *Oùir, entendre, écouter, comprendre après Schaeffer*.

<sup>2</sup> A specially designed font, called "Sonova", has been used to produce the graphic signs used in the diagrams.

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.<sup>3</sup> 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<sup>4</sup>.

Schaeffer's approach to schematization 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 characterized 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 organize 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 summarized in TARSOM, categorized 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 electro-acoustic music (or of bird songs, or of ethnic musics), let us briefly summarize the reasoning behind the proposed revision of Schaeffer's original design,

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 28 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.<sup>5</sup> 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, i.e. 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 15 cardinal cases (for the original TARTYP, see appendix). What needs to be done next is to fill the voids between the inner nine and outer six categories with transitional

<sup>3</sup> "Formules Typologiques" TOM 466-467

<sup>4</sup> TOM 350-351

<sup>5</sup> "*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 their pitch content and dynamic shapes. Thus all sounds have *entretien*, only some have *facture*." John Dack 1998.

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

### **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 electro-acoustic music.<sup>6</sup> On the other hand, it can be said that the lack of any conventions with regard to discussing and analysing electro-acoustic music is detrimental both to pedagogy, humanistic research, and possibly also to public comprehension and acceptance of this novel art form.

The paradox of electro-acoustic music is its role as a bridge over the gap between two cultures: On one side of the gap one finds the exact sciences of acoustics, informatics, and engineering – all of which define conditions of sound production, the very instruments of executing any compositional design. On the other side is the culture of music appreciation by the ear. Whereas the first aspect is heavily loaded with well defined verbal concepts that are shared among a community of specialists, the aural, musical aspect that embodies musical thought and project it to the audience is almost devoid of a consistent terminology as far as electro-acoustic music is concerned; there is virtually no common language by which even competent listeners may discuss listening intentions. Although it may well be a useful exercise to draw up a listeners' score based on signs and categories of one's own making, the result is nevertheless strictly personal, and will not necessarily contribute much to a meaningful discussion about the music itself.

Objectivity can be seen as a way to define an observer's perspective in a manner that enables others to see the object of observation from the same perspective. Objective sciences avail themselves of

externalized conventions, such as standards of measurement, defined algorithms etc. to achieve such common vantage points.

Scientific discourse seeks to eliminate ambiguity in its terminology and definitions. An artistic discourse would on the contrary often seek to be as polyvalent as possible, suggesting a network of meanings or implications. Thus the scientific ideal is more often than not alien to an aesthetically oriented discourse. However, there is also a need for some intersubjective agreements in the aesthetic field so that music can be meaningfully discussed in words. By teaching individuals how to master the intentionality of *reductive listening* (*écoute réduite*), we are able to create at least one such common basis of observation. Clearly, this will temporarily exclude a number of other intentionalities that are put in abeyance ("bracketed"), such as listening for causes (indexical listening) or listening for musical structures (musical comprehension) or a more empathic listening (oriented towards bodily sensations).<sup>7</sup> There is much to gain from establishing a general agreement as to the nature of different listeners' intentions, and to do this properly one should not enforce any particular listening intention as intrinsically superior. The point to emphasize is rather that different listening intentions are complementary, and each listener's flexibility with regard to being able to change between them should be encouraged. A kind of virtuosity exists for listeners as well – less conspicuous than that of the performers perhaps, but no less rewarding!

The present article presents a set of analytical conventions that presuppose the practice of a *reductive listening*. This intention is characterized 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 summarizes the Schaefferian thoughts on the subject succinctly:

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<sup>7</sup> In his above mentioned article on music analysis and reception behaviours, Francois Delalande outlines a few listening behaviours: Taxonomic Listening, Empathic Listening, Figurativization feature prominently in his article; in addition he proposes "Search of a Law of Organization", "Immersed Listening", and "Non-listening". In *Spectromorphology: explaining sound-shapes* 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

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<sup>6</sup> See e.g. Francois Delalande 1998

“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 carry. 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...”<sup>8</sup>

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 have 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 systematized. 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 categorizing reductive listening. Each of these attitudes are valuable in its 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 is certainly not a spontaneous way to listen to sound. It goes well with the “taxonomical” approach to listening, i.e. listening to the way the music is ordered (what are the units the piece fall into? What are their relationships? etc.).<sup>9</sup> This is of course not a spontaneous, “layman” way of listening either. How-

ever, to a musician and a composer, it is a necessary and required professional capability to master these listening intentions.

We shall now discuss in more detail the reorganization 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.<sup>10</sup>

### Detailed presentation of the revised typology.

The minimal representation of the typology (**Fig. 1**) shows only cardinal cases – the extremities of the organizing 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

<sup>10</sup> 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 analyze the physical aspect of sound and link the result of the analysis up against an interpretation into typomorphological 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 interiorization of sonic qualities and their orientation in an overall conceptual structure is a prerequisite for an intuitive, creative mental process.

<sup>8</sup> GOS p.33

<sup>9</sup> See the article by F. Delalande, footnotes 7 and 8

## ENERGY ARTICULATION

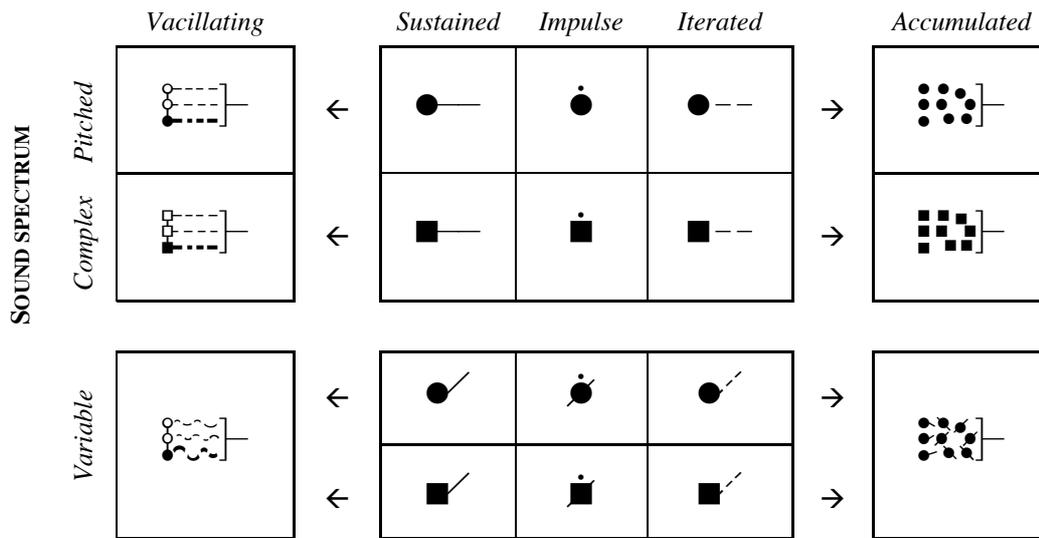


Figure 1. Typology – minimal representation.

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 tonic 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.

### 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. See **Fig. 2** for the expanded diagram.

One type of sound spectrum has been inserted between pitched and complex sounds.

- This category is termed *dystonic sound objects* (corresponding to Pierre Schaeffer's *sons cannelé*).<sup>11</sup> 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*).
- The open diamonds will be used for whisper-like, quasi-pitched sounds.
- Empty square note heads will be used for “un-voiced” 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<sup>12</sup>). This is actually a huge sack containing several subcategories, moving from relatively simple cases towards increasingly complicated objects. The simpler cases would e.g. 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

<sup>11</sup> See GOS 146,148

<sup>12</sup> See TOM 464, 466, GOS 140.

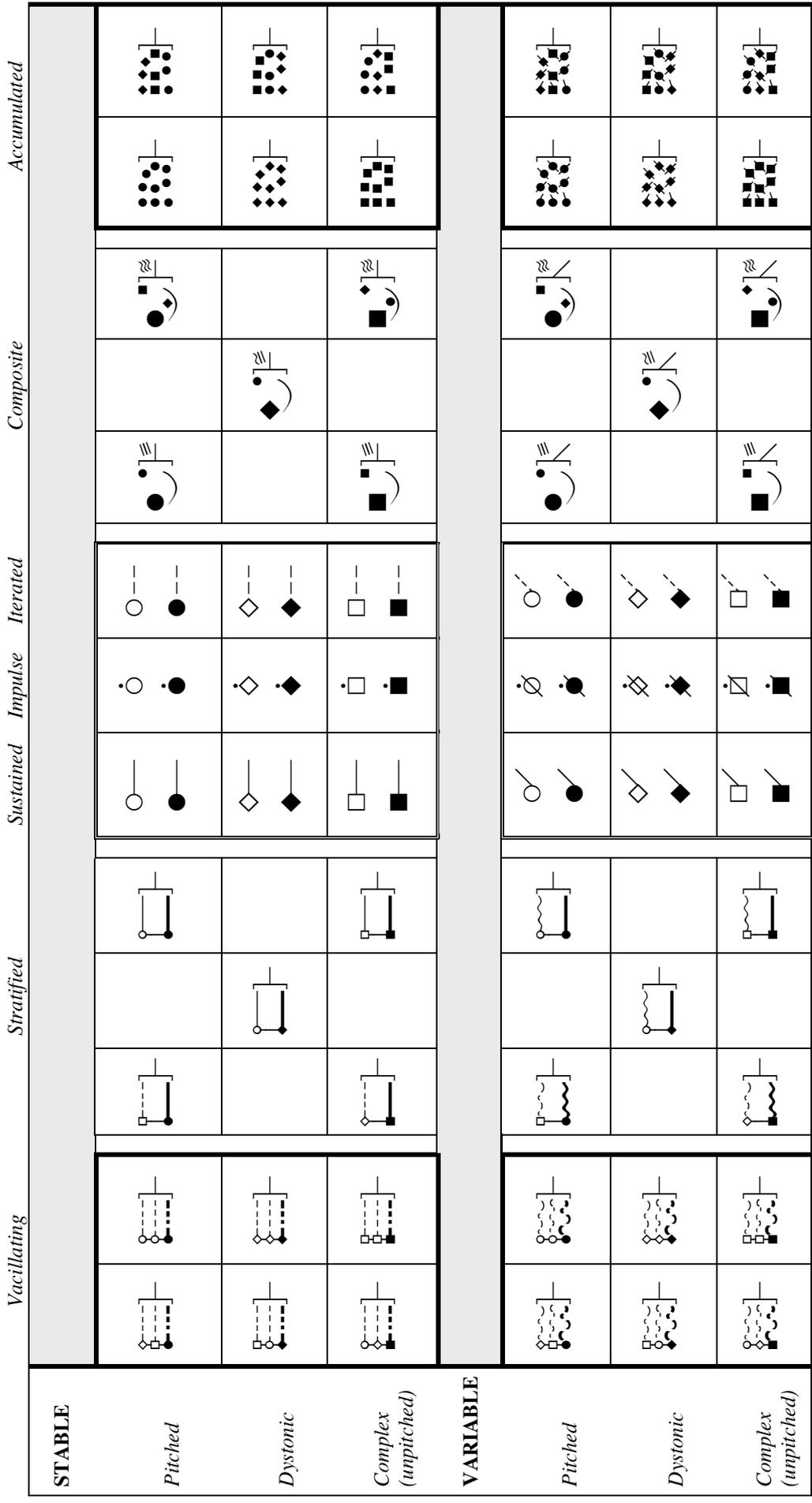


Figure 2. Typology - expanded diagram.

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<sup>13</sup>). 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.

**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.

**Types of velocity and duration**

The central category of velocity/duration is equivalent to the duration’s characteristic of Schaeffer’s *tenués formés*.

- This central category is called *Gesture time*. 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.

To the category of very long 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*”.

- The very long/slow durations/velocities will be termed *Ambient time*. 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/protection limits of immediate perception.

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.

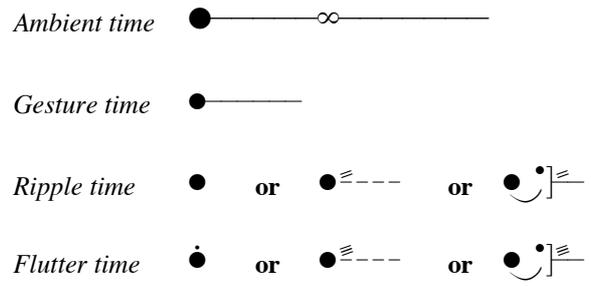


Figure 3. Types of velocity and duration.

- The fast velocities will be called *Flutter time*. To the extent elements integrate, they become iterated objects, which is a case already covered in the diagram. Between flutter time and gesture time, there is a transitional region.
- The intermediary region between flutter time and gesture time we term *Ripple time*.

**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*, *Oblique* and *Irregular*.

	<i>Regular</i>	<i>Oblique</i>	<i>Irregular</i>
<i>Gestural time</i>	Rg	Oq	Ir
<i>Ripple time</i>	≡	≈	≈
<i>Flutter time</i>	≡	≈	≈

**Tendencies :**

<i>accel.</i>	≡	≈	≈
<i>rit.</i>	≡	≈	≈

Figure 4. Pulse categories.

<sup>13</sup> See TOM 464, 466, GOS 140

- *The regular pulse* divides time into equally long segments, or in equal number multiples of segments.
- *The irregular pulse* divides time into unpredictable durations.
- *The 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 even pulses.

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.

### 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.

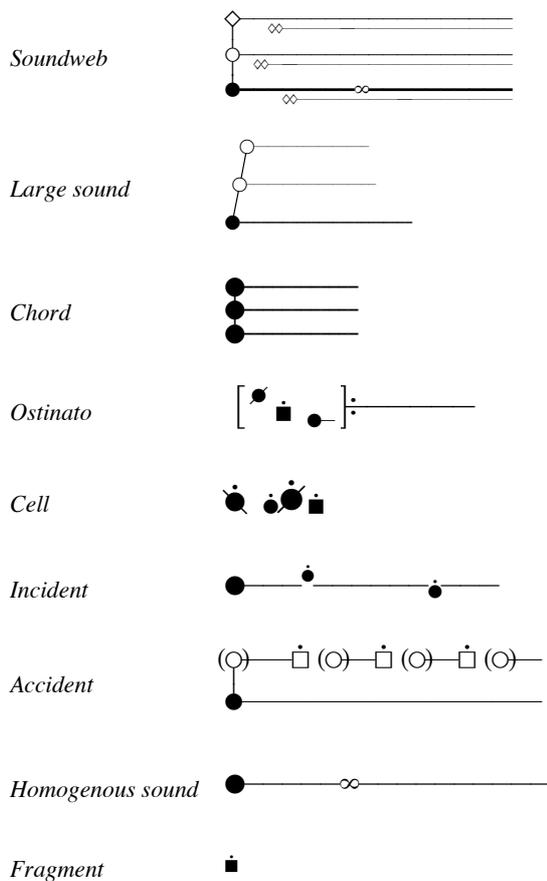


Figure 5. Schaefferian special cases.

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

### 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 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.

### Criterion: Sound Spectrum

- *Spectral width (classes de texture de masse)*.<sup>14</sup> The width of the spectrum is defined by the extremities of sinusoidal sounds and white noise. See **Fig. 6**.

The diagram begins with the sinusoidal shape, and then goes to the pitched sound with an overtone spectrum, especially an 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 suited 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 characterization 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

<sup>14</sup> See GOS 146

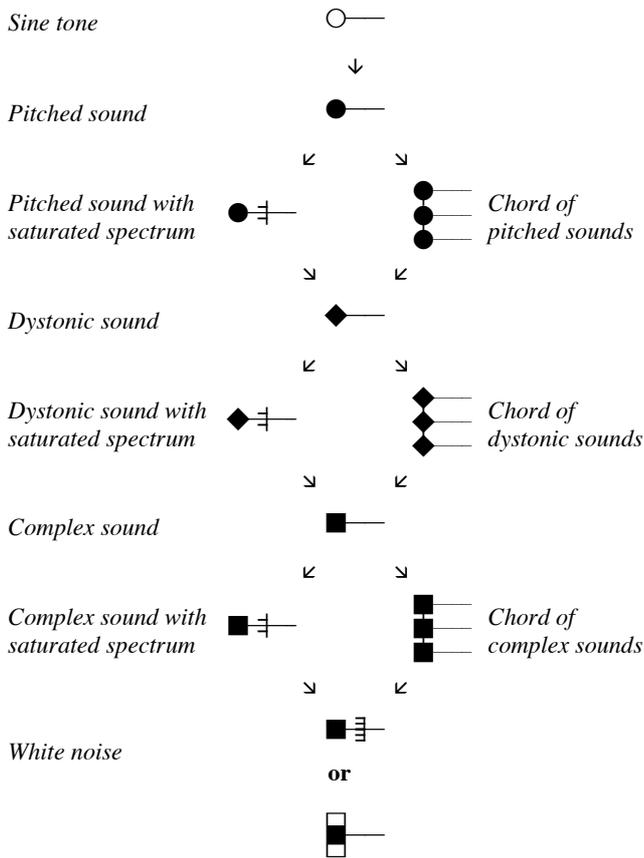


Figure 6. Spectral width.

be used; for continuously varying brightness, a sign characteristic of stratified, variable sounds will be used.

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

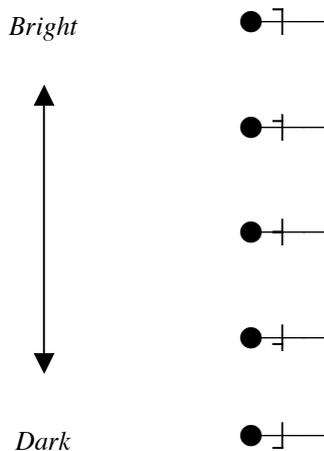


Figure 7. Spectral brightness.

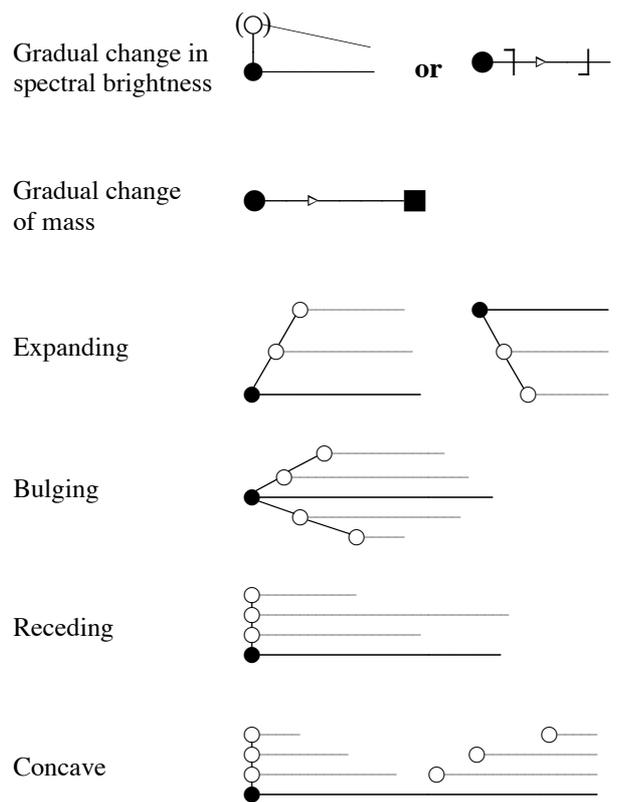


Figure 8. Spectral profile.

of as absolute, so that e.g. 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 indicated partial is put between brackets, it indicates that this is not perceived as a separate pitch or entity, but indicates a 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*.

**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:<sup>15</sup>

<sup>15</sup> See TARSOM, rubric 21; GOS 155

- *No dynamic profile* (*dynamique nulle*; no variation). Typical object: the homogenous sound – the static sound object in ambient time.
- *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 column on each side of the middle.
- *Impulse-like dynamic profile* (*dynamique-impulsion*; characterized by a sudden thrust and decline of energy, with no sustained phase).
- *Cyclic dynamic profile* (*cyclique*; repetitive dynamics.) Typical object: ostinato.
- *Vacillating dynamic profile* (*reiteré*; 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. These are 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, articulation and sound spectrum.

**Fig. 9** shows the proposal for onset phase genres; they differ in minor respects from those of Schaeffer:<sup>16</sup>

- *Brusque onset* (e.g. a sound caused by a metal hammer stroke against metal; the attack transient is clearly and separately perceived).

Brusque onset	● ▲
Sharp onset	● !
Marked onset	● 
Flat onset	●
Swelled onset	● <>
Gradual onset	● <
No onset	◀●

Figure 9. Dynamic profile.

- *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 e.g. 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 characterized by adding an indication of the spectral brightness of the opening transient. See **Fig. 10**.

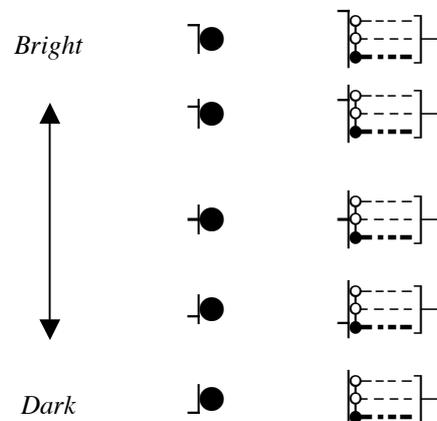


Figure 10. Spectral brightness of the opening transient.

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).

**Fig 11**. 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

<sup>16</sup> GOS 158

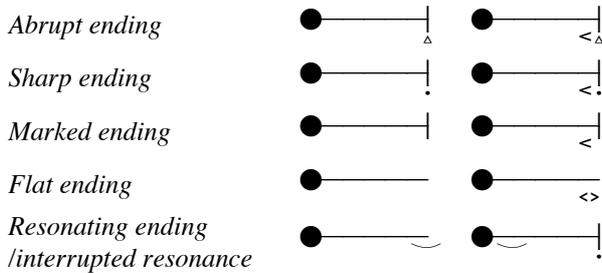


Figure 11. Ending genres.

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; ex. Vibrating string dampened with metal rod)
- *Sharp ending* (sounds with an ending phase containing elements intrinsic to the the main body of sound itself; ex. Harpsichord tone).
- *Marked ending* (sounds stopped suddenly, rather than rounded off).
- *Flat ending* (unspecified).
- *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 indicated 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 is an important special case. See **Fig. 11**, last column.

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). See **Fig. 11**, last column.

**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 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 generalized.<sup>17</sup> 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*,
- *Spectral gait*.

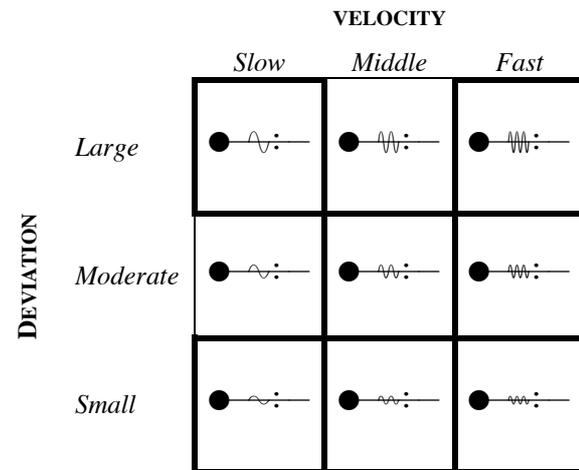


Figure 12a. Pitch gait.

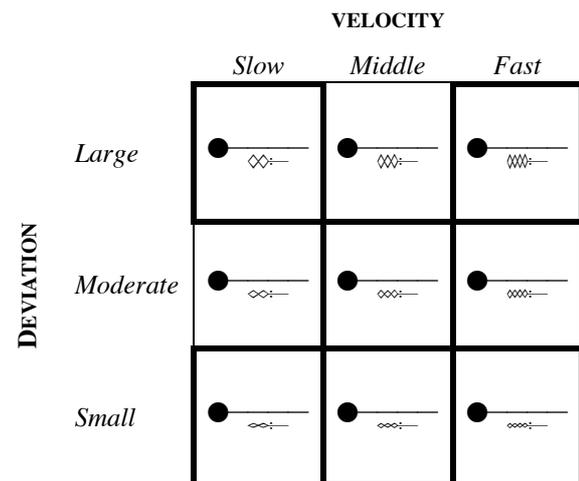


Figure 12b. Dynamic gait.

<sup>17</sup> See GOS 158

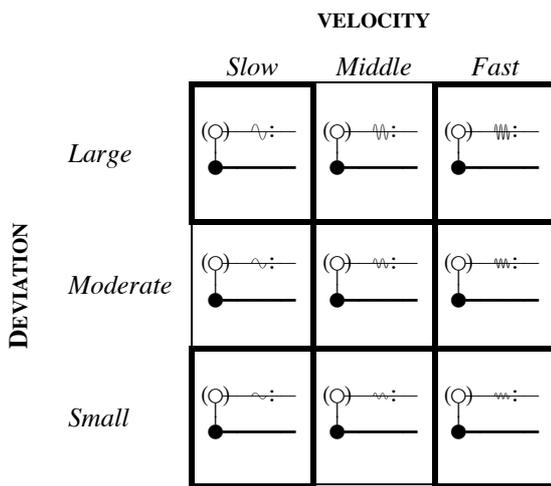


Figure 12c. Spectral gait.

The gait will be further analyzed with regard to its

- *Pulse velocity* (which will generally range from gesture time to ripple time; we will then add the tremolando-like signs shown in Fig. 4 and place it over the prolongation line of the gait sign).
- and its degree of *deviation* (i.e. the degree of its departure from an average value).

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 design of the diagram is meant to emphasize the five cardinal cases (extremes and middle position) – these would often be sufficient for practical purposes. However, the full diagram may of course be employed.

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 sound is vibrating. If one generalizes all sound sources to three overall categories, namely living (pre-eminently human), natural (i.e. phenomena of nature), and mechanical (i.e. produced by machines) it would appear that if living sources have a tendency to vibrate in oblique pulse, the natural ones in an irregular pulse, and the mechanical ones in a regular pulse.<sup>18</sup>

### 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 when can discern in a photograph. Granularity can there 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 over all perception of irregularities of detail (“grains”) that affect the surface of the object.<sup>19</sup>

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 as 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).<sup>20</sup>

A simplified representation of Schaeffer’s many distinctions of granularity is shown in Fig. 13a. 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.

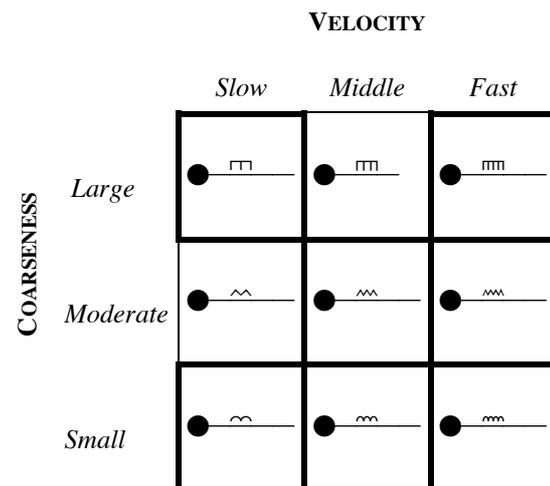


Figure 13a. Granularity.

<sup>18</sup> GOS 159

<sup>19</sup> See GOS 152

<sup>20</sup> See GOS 152-154, TOM 551-555

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)
- *The placement of the grain* (i.e. in which register the grain can be found)
- 

**Fig. 13b** shows the graphic notation of the latter categories.

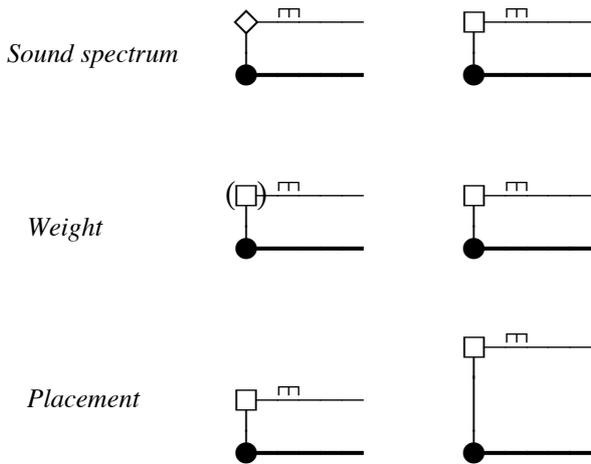


Figure 13b.

**General additional conventions of notation**

**Fig. 14** shows some additional conventions for using the graphic spectromorphological analysis.

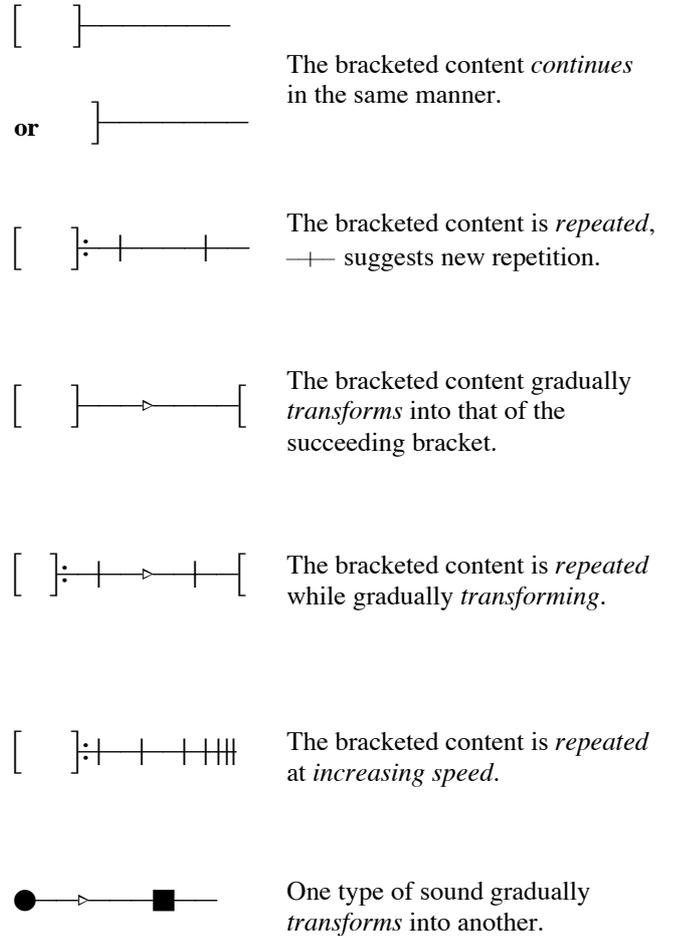


Figure 14.

## Addendum I: The original diagrams from TOM

### Addendum II: Analysis

Analysis of Åke Parmerud “Les Objets Obscurs”, third movement

#### References:

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Thoresen, Lasse (1985). Auditive Analysis of Musical Structures. A summary of analytical terms, graphical signs and definitions. *Proceedings from ICEM Conference on Electroacoustic Music Stockholm, Sweden, 25–27 September*.

Addendum I: The original diagrams from TOM

	Durée démesurée (macro-objets) pas d'unité temporelle		durée mesurée unité temporelle			Durée démesurée (macro-objets) pas d'unité temporelle	
	facture imprévisible	facture nulle	durée réduite micro-objets			facture nulle	facture imprévisible
			tenue formée	impulsion	itération formée		
hauteur masse définie fixe	ECHANTILLONS (En)	Hn	N	N'	N''	Zn	ACCUMULATIONS (An)
hauteur complexe		(Ex)	Hx	X	X'	X''	
masse peu variable	(Ev)	Tx Tn trames particulières	Y	Y'	Y''	Zy pédales particulières	(Ay)
variation de masse imprévisible	unité causale E cas général    T cas général		W	φ	causes multiples mais semblables K cas général    Λ cas général		
			← sons tenus			sons itératifs →	

## Addendum II: Analysis of *Les Objets Obscurs*, Part III, by Åke Parmerud.

### Comments to the Analysis.

*Les Objets Obscurs* (1991) by the Swedish composer Åke Parmerud (b. 1953) consists of four pieces, of which we have analyzed only the third.<sup>1</sup> The piece was composed and produced in the studio of *Groupe Recherche Musicale* in Paris, and is dedicated to the founder of this particular organization, Pierre Schaeffer. The piece is composed in an idiom that fully conforms to the one that was created in this studio by Schaeffer himself, the composer Pierre Henry, and a great number of other composers working in the studio and shaping a “tradition”.

The pieces are formulated as four riddles stated verbally in the beginning of each movement. Each riddle invites the listener to guess what the sound sources of each piece are; the sounds are of course electronically transformed beyond immediate recognition. The sounds of each piece come from only one source. The riddle of the present movement is: “*Convex bodies cast out in a series of collisions. Random movements over uneven surfaces. Something that is loved without loving. Something that is collected only to be dispersed.*”<sup>2</sup> The listener is thus encouraged to practice “indexical listening”, i.e. to direct himself/herself towards the physical events that caused the sounds. However, the solution to the riddle is somewhat banal – in the case of the present piece, part III, the answer is simply “marbles”; the sounds of the music are all derived through different technical transformations from the sounds of marbles. Nonetheless, what still remains is the very form of the riddle, the music itself. As Björn Billing puts it: “*Parmerud lets the answers to the four riddles in Les Objets Obscurs form a new riddle. This is odd in that it is its own answer, like the snake biting its own tail. A phenomenon that is closed but without an end, a “game where he who loses, wins, and where one both loses and wins with each throw” (Derrida). The answer to the last, all-encompassing riddle, the form of existence of the hidden things, is: la musique!*”<sup>3</sup>

We shall now go on to study the form of this riddle, the music as heard. Clearly, our study, too, will not be sufficient to reveal the ultimate solution to the riddle of this music or any music; hopefully, music will remain a perennial riddle. Analysis may, however, enable us to approach, although never definitively achieve, a close insight into how music is built up internally.

<sup>1</sup> CD information

<sup>2</sup> “Des corps convexes lances dans une série de collisions. Des mouvements hasardeux sur des surfaces irréguliers. Quelque chose qui est aimé sans aimer. Quelque chose qui s’assemble pour s’éparpiller aussitôt.”

<sup>3</sup> Björn Billing in *Nutida Musik* no. 1, 1992.

In conducting a spectro-morphological analysis we shall have to turn our attention away from speculations about what has produced the sounds of the piece, and instead listen to the sounds as they are heard. After listening all the way through the piece as a whole a few times, we focus our attention on single sounds, listening to them with a *reductive listening intention* aimed at *categorization*. The signs are at first loosely jotted down by pencil, without being bound to an exact time line. For fine listening to particular sounds, it is useful, but by no means essential to isolate the sounds one by one in a sound file and repeat them several times. But ultimately, they are printed on a computer with the *Sonova* font, following a timeline in seconds.

The symbols are placed on a time line in seconds so as to make it easy for the reader to coordinate the analysis with the CD recording; for the exact spatial placement of the signs in relation to the time-line, a spectrogram may be a useful tool. However, chronometric time measurements are not an intrinsic aspect of the analysis, which is based on music as heard. Now and then, the placement of the signs may show slight deviations from an exact placement on the time-line; the signs may have been somewhat compressed to suggest musical time field. This analysis presents an example of a compact notation of all sounds in a single system. The pitch (or brightness) axis goes from low to high; however, it cannot always be exactly maintained due to practical reasons, as e.g. when many sounds occur simultaneously in the same register.

As a result we get a *listeners’ score*, thus a *descriptive* representation of what is heard. A traditional score, on the contrary, would be *prescriptive*, i.e. used for reproducing the music.

The final result of the analysis is shown in **Fig. 15**. Given the presentation of the analytical terms above, the analysis and categorization of the sounds does not need further explanation.<sup>4</sup> However, since making the analysis in-

<sup>4</sup> The analysis of the piece by Parmerud is basically a spectro-morphological description/interpretation. Beyond this, we have developed several analytical tools to describe emergent properties of the whole, such as successive and synchronous grouping, and formal function, transformations and processes. To proceed with the analysis of this piece, I would suggest the following steps:

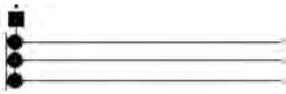
1) The spectromorphological analysis will be used to identify *families of related sounds* (thus a “characterologie” in Schaefferian terms). The recognizable identities of the families will later serve as *formal segments* in an analysis of *formal functions* (i.e. *recurrence, variation and contrast*). I would suggest there are more or less five different families in this piece.  
2) Sounds from different families are integrated into *characteristic configurations*; the more characteristic ones would have to be identified (the most characteristic integrated sound configuration is in my thinking the one occurring between 4” – 30”): A crescendo + accelerando of shorter objects before the

volves deciding a number of ambiguous cases, a brief discussion about these may be useful.

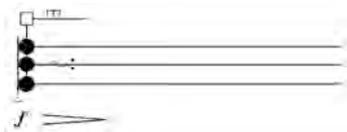
### Discussion about analytical choices made in the analysis.

The present approach to analysis – indeed most forms of analysis – transfers information from a concrete reality with an almost infinite number of shades and nuances, into a conceptual space with a limited number of distinct positions and categories. The analyst will have to make certain choices regarding how to divide continuous phenomena and assign them to a discrete, conceptual category. Please note that the time indications in seconds start after the reading of the French text, i.e. after appr. 18'', and will there differ correspondingly from the seconds showed on the CD recording of the music.

- [0"] The music starts with a chord of several *tonic* sounds. The attack of the chord contains a *complex impulse*. This could have been explicitly indicated in notation like this:



However, the use of the sign for *brusque attack* already indicates an attack containing a transient sound of *complex spectrum*, separate from the continuation of the sound. Therefore the notation can be simplified as follows:



The *pitch gait* symbol has been used to capture the instability of the spectrum of the chord. The sign

---

chord, then the resonance of the chord being prolonged into an ascending glissando that is interrupted by shorter events).

3) The *gestalt-formation* of this and other sonic gestures would have to be considered (thus between 4''-30'': a short *forward-leaning phase* followed by *presence oriented accent* with *goal function*, *long backward-leaning phase*). This analysis would then be extended to an analysis of the *dynamic form* of the piece as a whole. Thus an extended (culminating) presentation of this gestalt takes place 1'30'' – 2'30''.

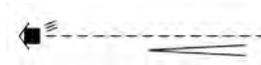
4) A condensation of the form into a compressed formula of essential features would be attempted.

However, it would go beyond the scope of the present article to present the conceptual structures of methods of aural analysis that have been presented in other publications.

of a *spectral gait* would have been more adequate, but is hard to accommodate graphically.

In the background, sounding simultaneously with the chord, there is a faint rattling. As it may be heard as belonging to the spectrum of the chord, we have chosen to notate it as *granularity*.

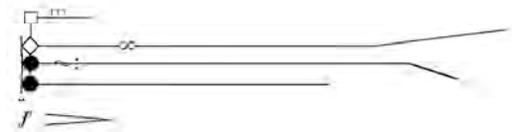
- [1.5"] A *complex, rapidly iterated* sound is gradually increasing in intensity (*crescendo*), leading up to the onset of the next chord:



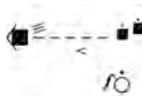
- [4"] The three sound objects just before the next chord, are notated as *dystonic*, because they have a very vague pitch quality of a somewhat "metallic" nature; alternatively they could have been characterized as *complex*. The first two have a medium *granularity*; the last one has *coarser* and *slower grains*, bordering on *iteration*. It is nevertheless notated with a sign for coarser grains to show its resemblance to the two previous objects in the group:



- [5"] As the chord gradually fades out a *dystonic* component comes to the foreground. The ascending glissando has a somewhat "noisy" timbre. As it does not have a dense spectrum, the unfilled symbol (for "unvoiced" sounds) is used:

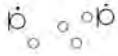


- [17'] An iterated sound, very much like the one at [1.5'] leads up to a short *tonic impulse* and two *complex impulses*. The tonic sound is simple in nature, not really a sine tone, but without prominent overtones. The second complex impulse is slightly *brighter* than the first. As they are both very brief, they do not have an onset. Although the onset sign could have been used here to transmit to the reader the perceived abruptness of these sounds, this would not have been in strict accordance with the definitions pertaining to onset notation:



- [22.5"] Here is a group of short tonic sounds, a *cell* listed under Schaefferian special cases above, in which the first and the last ones are accentuated. Although they

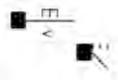
are not pure sine tones, not least because of the sharp, somewhat complex attack, they are a borderline case and are thus notated as such. The *cell* could also be notated as a *compound object*; however, since the objects are separate and do not really fuse, this notation is not used.



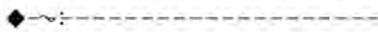
- [31.5"] This sound, although brief, nonetheless has a short resonating body. In this case it is appropriate to combine the sign for a *sharp onset* with that of an *impulse*:



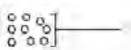
- [38" & 39"] These two sounds are actually a bit more intricate than the notation would suggest. Given their briefness, it was thought that this simplified notation would suffice:



- [1'10.5"] A simplified representation of two sonic events is used here. The sounds are similar in timbre, the first slightly higher pitch, the second an iteration varying in pitch:



- [1'1.5"] For this *accumulation*-type sound, the open version of the tonic sign is used:



The spectrum of the constituents is much simpler (sinusoidal) than those at [43"]. The sound reoccurs at [1'4"] and as a short interrupted *fragment* at [1'10"]:



- [1'8.5"] Here the *complex granular* component is notated as a separate sound, since it has already been presented individually at [1'1"]:



It can also be noted that the *dystonic* part of the characteristic chord is here presented before the onset of the tonic part (at [1'7"]). The internal structure of

what was previously perceived as one sound object is here revealed:



- [1'11"] A series of *short, complex impulses*, grouped together as cells. The chosen notation is an attempt to reduce the clutter that would result if each one were notated individually. The wide differentiation in brightness (or register) of the individual sounds is here shown with the use of the signs for spectral brightness. The broken line implies separation by silence:



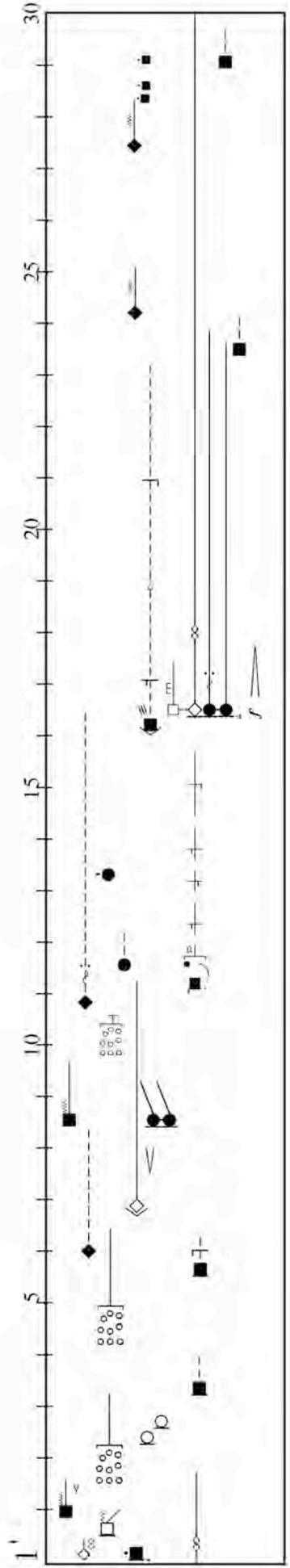
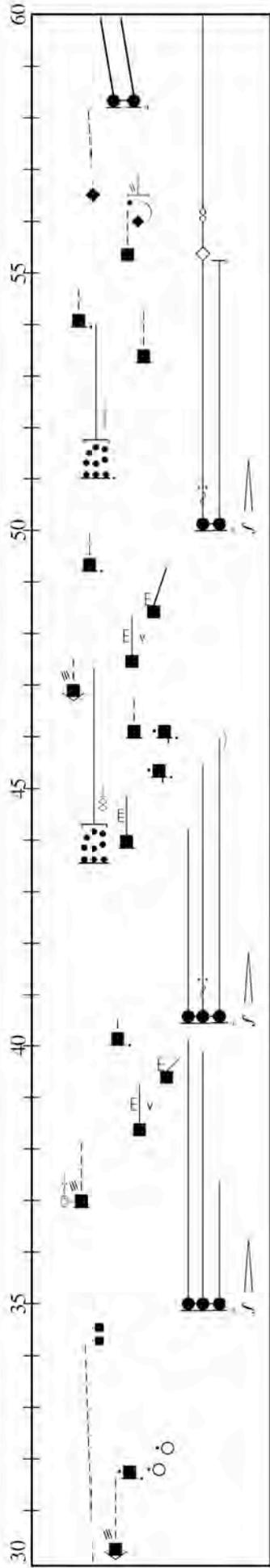
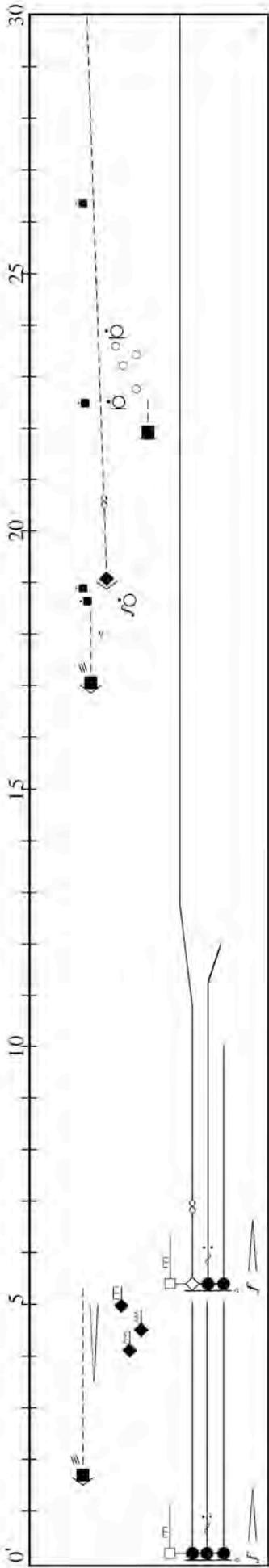
- [1'15.5"] The notation of the *spectral brightness* is here used in the proper manner. We hear a gradual transformation in the complex sound, from bright to dark, without the main body of the sound changing register:



- [1'30.5"] Dystonic sounds appear in a polyrhythmic setting. This is rendered by the sign for *oblique pulse*. This first occurrence is very much in the background, but the sounds are repeated with gradually increasing intensity until it reaches the climax at [2'0.5"]:



Fig. 15. Ake Parmerud "Les Objets Obscurs", part 3.



Musical score for the first system, measures 30 to 60. The score is written on a single staff with a treble clef and a key signature of one flat. The tempo is marked *Allegretto*. The score includes various musical notations such as notes, rests, and dynamic markings. A dashed line indicates a section starting at measure 45. The dynamic markings include *ppp*, *pp*, *f*, and *ff*. The measure numbers 30, 35, 40, 45, 50, 55, and 60 are marked along the top of the staff.

Musical score for the second system, measures 1 to 30. The score is written on a single staff with a treble clef and a key signature of one flat. The tempo is marked *Allegretto*. The score includes various musical notations such as notes, rests, and dynamic markings. A dashed line indicates a section starting at measure 25. The dynamic markings include *pp* and *ppp*. The measure numbers 5, 10, 15, 20, 25, and 30 are marked along the top of the staff.