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Emerging Musical Structures: A method for the transcription and analysis of Electroacoustic Music

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EMERGING MUSICAL STRUCTURES: A METHOD FOR THE TRANSCRIPTION AND ANALYSIS OF ELECTROACOUSTIC MUSIC.

by

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Abstract

EMERGING MUSICAL STRUCTURES: A METHOD FOR THE TRANSCRIPTION AND ANALYSIS OF ELECTROACOUSTIC MUSIC.

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Advisor: Distinguished Professor Joseph N. Straus

This dissertation proposes a method for transcribing “electroacoustic” music, and subsequently a number of methods for its analysis, utilizing the transcription as main ground for investigation. The core of the investigation is on pieces that seem particularly resistant to traditional musical analysis, as they present at least three crucial differences with respect to the “standard” repertoire: they utilize (completely or in part) non-pitched sounds, they focus on timbre avoiding traditional strategies of pitch and rhythm organization, and they are not traditionally notated. Pieces by Agostino di Scipio and Douglas Henderson serve as case studies to demonstrate the efficacy of the developed analytical techniques. The methods proposed are the result of the combination of objective measurements with perceptual data, and of existing procedures of musical notation and analysis with my own intuitions. Assuming that certain perceptual mechanisms are akin to all musical styles, the ultimate goal of this research is that of showing how and what kind of local and large-scale organizational patterns can emerge by listening to electroacoustic music.

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As my doctoral journey reaches its end, I would like to thank all those who contributed in making it a fundamental formative enterprise. In particular, I am deeply grateful to Joseph Straus, for his invaluable help and support over the years, to Mark Anson-Cartwright for his important and timely feedback on this work, and to Jeff Nichols, Philip Lambert, Shaughn O'Donnell, and Stephen Blum for their teachings. My gratitude goes as well to Agostino Di Scipio and Douglas Henderson—whose compositions are the subject of this dissertation—for their priceless collaboration, and for allowing me to reproduce their scores and documents. I am greatly indebted to my family, in particular to my father Emilio, for his continuous support and encouragement. Finally, a special thank is reserved for my wife Eleonora for being on my side throughout this venture, for tenaciously enduring my frequent mental and physical absence, and for being the greatest possible mother to our daughters Chiara and Elena. It is to her that this dissertation is dedicated.

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Emerging Musical Structures: A method for the transcription and analysis of Electroacoustic Music.

Introduction

This dissertation develops a method for transcribing and analyzing electroacoustic music. With this nomenclature, which is not universally recognized to indicate a specific genre—many people exchange it freely with the terms “acousmatic” music, “experimental” music, “electronic” music, etc.—I refer to music that focuses on timbre, and that includes both electronic (i.e., computer-generated or -controlled) and acoustic (i.e., real-life) sounds as a source of material for the composition.

In order to narrow the scope of the work, I have chosen to focus on electroacoustic pieces that seem particularly resistant to traditional musical analysis, as they present at least three crucial differences with respect to the “standard” repertoire: they utilize (completely or in part) non-pitched sounds, they do not employ standard techniques of pitch and rhythm organization, and they are not traditionally notated.

The examined repertoire will be drawn from the work of two contemporary young composers, both of whom are living and born in or after 1960: Agostino Di Scipio and Douglas Henderson. The reason for choosing young composers is quite obvious: the most recent generations are more familiar with the electronic medium, and more committed to exploiting it. Because technology allows research in directions that were not previously possible, it is in the work of those using it that we find the most challenges with respect to our traditional understanding of musical structure, which is based on theories largely developed before the advent of electroacoustic music (or at least independently from it).

Naturally such challenges tend to increase the gap between the theoretical discourse on music and the work of many contemporary composers: one could argue that the advent of experimental music, and the progressive abandonment of composition with notes by many contemporary composers, is transforming music theory into a historical discipline, without relation to a significant part of the present practice. In order to fill the mentioned gap, several scholars have attempted to engage a discussion of electroacoustic practices.

Indeed, the approaches followed by those who have tackled the subject are various. However, generally they do not seek to clarify the structure of the musical output from the point of view of the listener (with some exceptions, as we will see). More specifically present studies of experimental music present a few common characteristics:

a. They are almost always written by composers (the consideration of the experimental repertoire is systematically avoided by music theorists, who appear skeptical when facing the unorthodoxy of this music, and the lack of a traditional "score").
b. They either focus on compositional strategies or methods of classification of timbres rather than analyzing structures emerging from the finished work.
c. They have generally no connection with preexisting analytical theories.

These characteristics are indicative of the difficulties posed by the topic. Indeed, those who have performed an analysis of experimental music that is not an observation of the compositional method have encountered significant problems. Since at a first approach much experimental music appears hard to reduce to clearly identifiable, easily manageable components, recognizable along a large part of the repertoire, current theoretical models seem almost impossible to apply to it. Even the most modern musical theories, some of which aspire to cross-genre application (i.e., transformational theory, space modeling theories, density-based theories, etc), are always oriented toward pitch or rhythm, and assume a universe of twelve equaltempered semitones and the presence of a predetermined rhythmic structure. They appear thus not well suited for note-less music, which bases its aesthetic on the multidimensional character of timbre.[1]

I like to think, however, that the basic premises of existing analytical models can also be applied to electroacoustic music, in that they are based on our common perception of sound organization in time. In the end, regardless of how a piece of music is put together, what we are confronted with is a collection of sounds, and therefore the same sorts of interpretive strategies that people use for music based on pitch and rhythm (including techniques for grouping and recognizing similarities among disparate phenomena) can also, at least potentially, be used for timbre-based repertoires. The epistemological ground of my claim can be found in studies in musical cognition. Following scientific, experiment-based results, these seek to determine what are the strategies that human beings employ during the act of listening to music. Most notably I should cite François Delalande (1998),[2] who listed three primary listening behaviors (taxonomic, empathic and figurative), and Lerdahl and Jackendoff (1983), who attempted to develop a universal listening grammar. The latter case is important as its intent is in a way opposite to mine, namely to criticize the complexity of experimental music rather than embrace it. Nonetheless, the idea of sorting out the capabilities and the limitations of our listening process has been influential for my work. Indeed, I do not wish to wish to engage in theoretical speculation, but to remain within an intuitive framework, avoiding reliance on what can be

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[1] See more in C. L. Krumhansl (1989)."Why is musical timbre so hard to understand?", in *Structure and Perception of Electroacoustic sound and music,* Nielzen S. and Olsson O. (eds.), Amsterdam: Elsevier.

[2] F. Delalande (1998). "Music Analysis and Reception Behaviours: *Sommeil* by Pierre Henry," *Journal of New Music Research,* Vol. 27, No. 1-2. Lisse: Swets and Zeitlinger: 13-66. Here Delalande insists on the subjectivity of the act of listening, and on how musical perception varies not only from person to person, but also between different listening sessions by the same person. In the end, however, he is able to determine how certain behaviors appear to recur across different listeners.

demonstrated but cannot be perceived.

My main goal is that of engaging a methodology that can be considered music-theoretical. As such, it will require only basic knowledge of the physical/mathematical properties of sound, and it attempts to provide a way to discuss “musically” any sounding product realized with the intention of creating music, acknowledging the incredible variety of results achieved by contemporary composers, and considering them without prejudice.

In order to achieve in this task I need first to provide a basic tool that will allow a discussion based on musical elements: I need to find a basic model for transcription, simple enough to read, and relatable to our common understanding of musical codes. This will allow me to examine a piece by pinpointing traditional elements of musical structure (form, gestures, melodic contours, motives, rhythms, repetitions, etc). This model, however, will need to take into consideration the element of timbre, a crucial structural element of the examined repertoire.

The first part of the dissertation will explore the problem of transcription and analysis by summarizing the state of the art in the discussion of electroacoustic music, focusing in particular on those exceptional studies that sought to provide means for musical analysis. In the second part I will engage in some case studies, providing my own transcriptions and analyses of two pieces by the aforementioned composers.

Chapter 1
Transcription/Representation as basis for analysis

1.1 Introduction

Electroacoustic music lacks a universally accepted notational practice; actual notation often does not even exist for a given musical work. Even when an attempt at notation does exist, perhaps in the form of compositional sketches, it is usually idiosyncratic and lacking the consistency and details necessary to conduct a musical analysis. In this regard, Bossis (2006)[3] makes a point of distinguishing “scoring” from “notation.” “Scoring,” Bossis explains, “is a tool used for creation and allows the generative thought to find its points of reference.” In this sense, even in electroacoustic music, a multiplicity of scores does exist. “Notation, on the other hand, allows the music contents to be transmitted as precisely as possible to the performer,” and, we might add, to the analyst. Indeed, Bossis adds, “when the notation designed by the composer falls short, the analyst can only rely on the acoustic evidence and create his own transcription.”

The general problems related to aural transcription, however, are well known. If, on the one hand, a traditional score represents a detailed and—at least under certain parameters—unquestionable representation of the musical output, which stays the same for any given observer, aural transcriptions are always subjective: they change from one interpreter to another, and are themselves causes of arguments. Indeed, if a score lies before the musical output, and its fidelity to the composer’s intentions cannot be argued, a transcription occurs after the output, and as such is automatically subject to interpretation: the sonic result of a scored piece is always compared to the score, whereas a transcription of a non-scored piece is always compared to the

[3] B. Bossis (2006): “The analysis of electroacoustic music: from sources to invariants.” *Organised Sound* 11(1): 55-62.

sonic result. They lie, in this sense, on opposite poles; they are complementary. Yet they can serve the same practical function, that of providing a visual aid to following the piece: of isolating and classifying the sonic events that occur in the time span of a musical work. This function is crucial to the analyst, who could not analyze, who could not dissect and relate if a work were not divisible into discrete units and segments.[4]

In addition to the subjectivity issue, with respect to other musical genres that are not properly scored and require post-compositional representation, transcribing electroacoustic music appears particularly challenging because the sonic message of such music is, as we know, very complex: it involves at any given moment multiple sounds of undetermined pitch, unfamiliar timbre, and irregular, inconstant rhythm. This is why many have resorted to technology in the attempt to rationalize their observations.

Naturally, technology, and especially recent technology, can allow scholars to detect aspects of the sound signal that could hardly be identified by ear. Furthermore, a computerized representation allows (or seeks to allow) a "uniformization" of the method, such as what we find in traditional music: if two analysts use the same software (or at least the same type of computerized representation), then the basic format of their representation (the score at hand) will always be the same (even though their interpretation may differ), thus eliminating the principal problem of aural transcription. Fully automated representations, however, raise issues of their own, as we will see.[5]

There exist three main categories of visual representations of electroacoustic music. The first category includes efforts that aim to represent the music in an intuitive fashion: this does not

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[4] This analytical principle is of course well known to ethnomusicologists, who dispute the accuracy of each other's transcriptions on a daily basis.

[5] In this regard Bruno Bossis (2006) states that "although current methods of spectral investigation by FFT or automatic segmentation permit a certain illumination of the structure of acoustic textures, they remain considerably below the level of precision obtained by the careful reading of a traditional score.

necessarily imply a lack of detail, but a focus on the perceptual dimension, rather than the physical dimension of music. The second, on the other hand, includes efforts that aim to objectively represent the music on paper (objectively, that is, with respect to the physical properties of sound: frequency, duration, and amplitude); the third category includes efforts that appear as combining the aims of the first two categories.

The first category, indeed, relates to aural transcription as mentioned above: a graphic representation realized after listening to a performance or a recording of a given piece; this includes rough graphic scores created by composers, often for publication. The second category is concerned with types of representation that are either technology based (performed by a computer according to a precise identification to the sound components), or with "post-scoring" notation: a type of notation that reflects an exact quantification of sound parameters as found, for example, in the composer's computer "score" originally written in some kind of programming language (e.g., Lisp).[6] The third category combines the first two by way of portraying details that are characteristic of the physical dimension of sound along with elements that relate to our intuitive perception of sonic events.

Despite their differences, all categories involve ways to characterize the sonic events of the pieces under examination, namely to identify, segment, and classify them, among other things, based on their timbre. This strategy allows the introduction of a new layer of observation in the notated medium, which is meant to serve two main purposes:

1. To describe a feature that is paramount to the aesthetic of most experimental music: the exploration of the "color of sound" as a compositional goal.

[6] These sometimes stem from the composers' intention to portray exactly on a timeline what they have realized in the actual software algorithms, which contain specific information about frequency, amplitude and duration of the sounds to be produced by the computer. These endeavors are closer to the process of scoring, although they only come into being after the piece has been written on another "medium." An example is found in Stockhausen's *Studie II*, as reported in Bossis (2006).

2. Considering timbre as an identifiable structural element provides the analyst with a new tool for segmentation and grouping, which may prove essential when some or all the remaining observable dimensions appear to be blurry or insufficiently defined.[7] In such cases relating timbres appears as a possible analytical "safety net."[8]

There is of course a lack of consensus about whether one should prefer the first, second, or third category of representation of electroacoustic music. All three present both advantages and problems, which seem to become more or less prominent depending on the sub-genre of electroacoustic music taken into consideration.

Let us then examine some solutions presented over the years by scholars interested in providing transcription and analysis of electroacoustic music.

1.2 Brian Fennelly

A noteworthy early attempt at transcription is Brian Fennelly's. Fennelly aims at the creation of a "systematic, straightforward means for the concise identification and characterization of sounds encountered in the tape literature." (Fennelly: 1967: 80) Fennelly's

[7] Indeed, focusing on timbre may prove particularly useful to counteract the relative inaccuracy inevitably resulting from the transcription of music, which is naturally due to our cognitive tendency to approximate percepts in order to create clearly distinguishable categories. In transcription, and especially in the transcription of experimental music, such inaccuracy is manifest in the pitch dimension, the time dimension, and in the loudness dimension: in all dimensions pertaining to traditional notation.

[8] Bossis (2006), however, is wary about the possibility of using timbre as a tool for segmentation. He writes "These timbres [those found in electroacoustic music] do not refer to traditional typologies. Classification by predefined categories is made even more difficult because certain sound fragments may or may not be perceived as coming from the natural world, a real phenomenon, a voice or an instrument. Furthermore, accepted technologies permit a perfect continuity between characteristic timbres…This does not imply sound *morphing*, but rather a non-discretizing of the timbral domain into defined subgroups. Musicologists find themselves confronted with a field whose cartography is not standardized, nor is it possible to standardise it." Although Bossis mentions some of the most renowned efforts of grouping timbres, such as Pierre Schaeffer's, he promptly concludes that "composers and musicologists rapidly abandoned these unreliable methods of differentiation." Here Bossis addresses an important issue and he is right: timbre seems impossible to "classify in predefined categories." However, analysis does not necessarily rely on the predefined, but also on the contextual. The latter domain, indeed, can lead to satisfying results.

attempt sprang from a failed attempt at analyzing a piece by Franco Evangelisti by a group of Yale University students. Fennelly notes that "the lack of a system by which the 'orchestration' of any passage might be concisely defined was a barrier to group communication, thwarting formulation and discussion at the desired level of detail." Fennelly decides to proceed in his intent even if he is well aware of the problems related to transcription by ear: "…the analyst must confront the actual sound; the ear is his only guide…The result of such an approach may reveal discrepancies between the aural analysis and one done only from a score, pointing perhaps to inadequacy in auralizing the printed note or to a particular fallibility of the ear." Indeed he suggests that his methodology may be utilized by composers in notation, in an effort to bridge the gap between production and reception of the work.

Fennelly's approach consists in classifying audible sounds based on a description of their main components: timbre, envelope, and "further defining characteristics, as beating, amplitude oscillation…or the use of reverberation;" Fennelly terms this last category "enhancement." What Fennelly seeks is a balanced system that can allow one to describe the heard sound as accurately as possible while avoiding an exact technical description, which not only is impossible to achieve by ear, but would also be useless for effective and manageable representation.[9]

Fennelly's task is realized through the use of a string of three symbols identifying the main categories to which the sound belongs, followed by a series of suffixes to portray the sound's idiosyncratic characteristics. These strings are then set onto a score-like timeline to define the sounds' occurrences in time, and are further complemented by the use of graphic signs and traditional score bits, clarifying elements that cannot be included in the string.

Fennelly's model string appears as follows: X_SY_CE, where symbols refer to "timbre of

9 This is one of the reasons I do not particularly favor the use of computer scores (i.e. computer algorithms) in musical analysis. They are technically difficult to interpret and often do not represent closely the audible sonic events of a piece, but merely their discrete components.

type X and spectrum S, envelope of attack Y and continuation C, and enhancement E.” Example 1.2.1 reproduces Fennelly’s Table I, which shows the main category of symbols applicable to X and S. Fennelly first recognizes two main categories of timbre X: pitched (I) and noise-related, or unpitched (II). These are further divided in 7 classes identifying more closely the nature of the sound (e.g., 1 indicates a pure sine tone, 7 a ‘natural’ unpitched sound, as that of a closing door). Symbols utilized for the subscript S describe instead the presence or absence of a certain range of partials from the sounds’ spectrum. For example, the letter H indicates that only high components are present in the spectrum. The last of these subcategories, F, indicates a fluctuating spectrum. In this instance Fennelly presumes the addition of a small graphic sign to clarify the typology of the fluctuation. Accordingly, the string $5_M Y_C E$ translates, in “Fennellian” transcription, into: narrow band white noise, with mid components only (lack of high and low frequencies), of Attack Y and continuation C, and enhancement E. For the timbral parameter, however, Fennelly also allows for other subscripts and superscripts to be introduced, in case further clarification appears as necessary to define aspects such as the overall registral placement of the sound (in case of a pitched sonority), or the resemblance with a real life sound object.

In the end, a complete string, in order to achieve a detailed description of a sound, can far exceed the initial model in length and complexity.   For example, in a transcription of *Fragment*, by Bulent Arel, Fennelly places his strings loosely on a time-line, i.e., without indicating exact attack points of each sound. In such transcription, the string indicating a “low rumble that begins at 70’’ and persists almost to the end [and] undergoes spectrum changes,” appears as: $\mathbf{5_{2q12dl\text{-}3}^{rumble} 0_a AM_{trem}}$, where all the numerical subscripts indicate perceived shifts in register.

Finally, the author proposes that Fennellian strings may also be used to indicate the overall character of a musical passage. The expression: “an instrumental line $X_S Y_{Cd}$,” describes a musical passage as having instrumental character X_SY_C, and "average distance between attacks within the line" d.

TABLE I: Timbre X_S

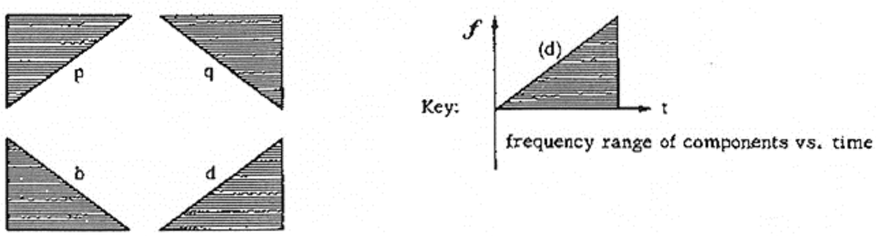
Timbre type X:

I	1. sine wave	I.—pitched, with fundamental or predominant tone
	2. square or sawtooth wave	II.—noise-related
	3. combinations*	* combinations of several sources perceived as a single unit
	4. "natural" (environmental analog)	
II	5. white noise	
	6. combinations*	
	7. "natural" (environmental analog)	

Spectrum subscript S:

G.	full, or nearly full spectrum
H.	high components only
MH.	midrange and high components
M.	midrange only
LM.	midrange and lows
L.	low components only
LH.	lows and highs only, midrange out
F*.	fluctuating

* Special cases of F:



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Example 1.2.1. Fennelly's Table I, showing the main category of symbols for timbre description

This last purported use of the string may be seen as opening the door to large-scale structural evaluation, as opposed to the description of single sonic events. To make a familiar comparison, applying a string to a musical passage could be similar to labeling a tonal passage as being in a certain key, as derived by the observation of its inner element (i.e., notes and chords). Even though Fennelly never puts this potential into effect (after all, his remark about a line

$X_S Y_{Cd}$ is merely identifying the "instrument" playing that line and its average rhythm), one can see how the intuition could be important for the analysis of electroacoustic music: it allows creating a context where a context seem to be lacking, or at the very least it allows to formalize the presence of relations whose existence may have previously been indefinite or unclear.

Even though forty-five years have passed, and even though the author himself has ceased to pursue electroacoustic music, both as a composer and as a scholar, his transcription method represents one of the most thorough and systematic attempts in the description of a form of experimental music ever to be conceived. However, Fennellian transcription failed to receive any success throughout the musicological community. To my knowledge it has been mentioned only in one example of pertinent literature[10] if we exclude his own contribution (his doctoral dissertation and the *Perspectives of New Music* article based upon it). The reasons for this lack of consideration are more evident than its achievements.

Fennellian transcription is at the same time difficult, bulky, too general to be specific and too specific to be general, time consuming, and, ultimately, impracticable. Even if one were to master the technique of Fennellian transcription to the point of becoming extremely accurate and quick in both creating it and deciphering it, the methodology would still fail to reach a fully satisfying result. Indeed, the best index of sonic type found in the string is ironically in the superscript "rumble." This basically means that the above string could be the same for two different sounds. This points to an inherent contradiction: there cannot be an aim to technical accuracy in representation (in the sign itself, in this case the string)of complex phenomena , if the representation has to be intuitively manageable. Manageability necessarily entails the

[10] Fennelly's method is mentioned in T. Tüzün. (2009). *Contextual Transformations in Timbral Space*, Ph.D. diss., City University of New York. Tüzün's work adopts the tenets of transformational theory in order to provide timbre-based analysis of spectral music. Tüzün is quite successful in his attempt. The repertoire he examines, however, is still very much note-based, and therefore he does not engage directly in transcription.

impossibility of being comprehensive.

Despite being largely impracticable, however, Fennellian transcription could be useful in certain scenarios, as we will see, and it should therefore not be dismissed entirely. It is of particular interest because it is one of the few methods that supposes that an accurate, objective "picture" of the sonic material may be drawn entirely by ear. In this sense his method lies within the third category of representation of electroacoustic music, and is highly reminiscent of the ideas of Pierre Schaeffer.[11]

1.3 Stephane Roy

Because it is in fact an aural transcription, Fennelly's method bears connection to the first category: intuitive transcriptions that seek to notate music through graphic signs. These signs are usually connected to the music in the same way traditional notation is, with two major differences: first, they incorporate idiosyncratic graphics in order to render some aspect of the timbral dimension visible on paper; secondly, they are not specific with regards to the pitch dimension, but they are "relative," as is normally the case even in traditional notation (think of unpitched percussion) for sounds whose pitch cannot be clearly identified.

Classic examples of first category representations are, as we have mentioned, composers'

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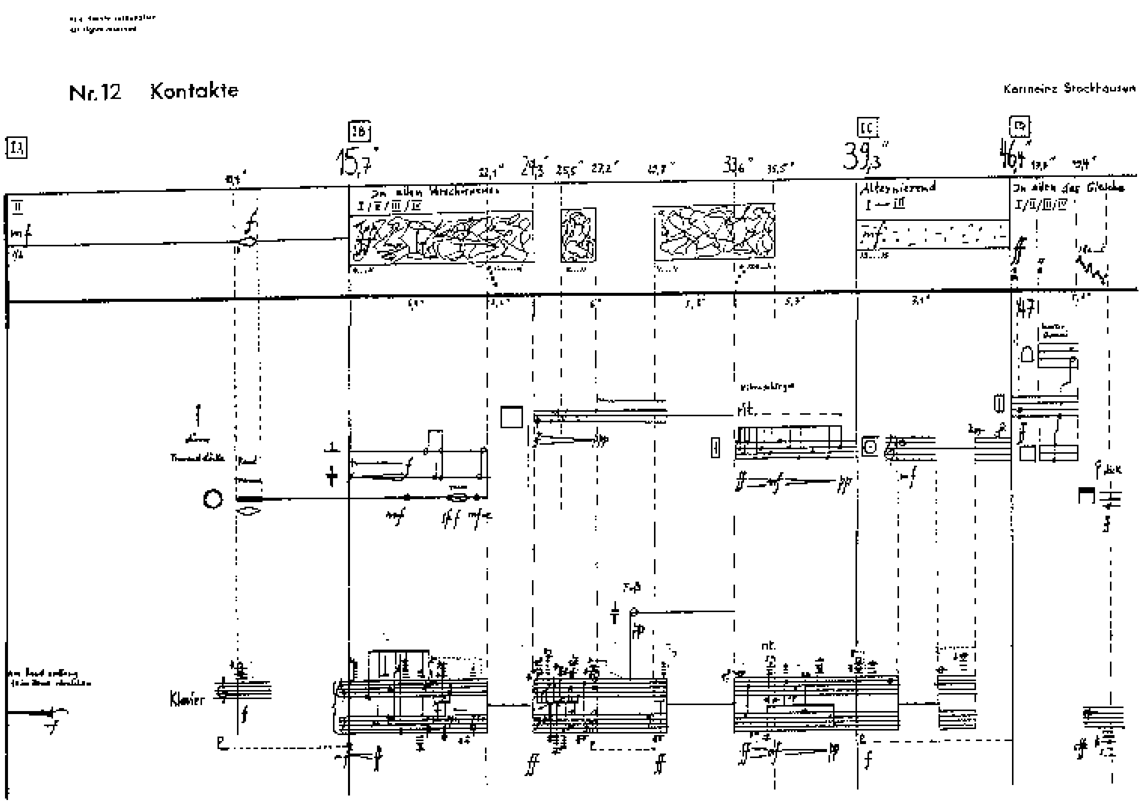
[11] Schaeffer has been possibly the most influential electroacoustic music composer and scholar of the past century. He is most known for his massive work "*Traite' des objets musicaux"* (1966), in which he provides a listening-based theory to categorize timbre. Indeed, he sought a way to classify every possible sound according to its perceivable morphological characteristics, and developed the concepts of "sound object," that is the minimum percept within an audio signal recognizable as a separate sound, and of "reduced listening," that is listening to the intrinsic characteristics of a sound object without taking into consideration, or being influenced by, its real-life source. Some of Schaeffer's followers, most notably Michel Chion and Denis Smalley, went on to become notable electroacoustic composers and scholars themselves. It is possible to assert that every single study in electroacoustic music ever produced so far, including this very dissertation (particularly the idea of segregating signals into sound objects), has been in some ways influenced by the work of Schaeffer and/or his followers. However, since I am not interested in a theory of sound classification, and since Schaeffer does not directly deals with transcription and analysis, I shall not provide a summary or discussion of his ideas.

graphic scores. These constitute the composer's own take at transcribing the music previously composed, for instance, at the computer. An example of this is Stockhausen's notation of the tape part in *Kontakte*, shown in example 1.3.1 (upper part of the score). These types of transcription usually do not apply a consistent methodology.

More consistent examples, however, consist of graphic representations such as those found in the implicative analyses of Canadian scholar Stephane Roy. Roy's transcriptions are analysis-driven: they are intended to reflect certain sonic characteristics, which in turn entail certain analytical considerations that are ultimately superimposed on the graphic transcription.[12]



Example 1.3.1. Stockhausen's notation for *Kontakte* (excerpt)

Roy (1996) implicitly acknowledges from the outset that his transcription belongs to the

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[12] This type of graphic analyses reminds us of Schenkerian graphs. In the latter, one extrapolates certain sounds (notes) from a piece that he deems particularly relevant, eventually emphasizing (through the use of certain symbols) those that are essential to the structure of the piece (e.g., the *Urlinie*). Although Roy's methodology for segmentation is entirely different, the analytical premise is somewhat similar.

first category, referring to Charles Seeger[13] in the distinction between prescriptive and descriptive score: "the score that I am using was realized through listening sessions after the work was composed. As a descriptive and listening score, it must not be confused with an instrumental score, which is prescriptive and contains a work in a 'to be realized' condition."[14] Roy also acknowledges the analytical nature of his transcription: "based on my perception of the work, this score already highlights the segments of the musical flow into individual perceptive units," therefore integrating subjectivity in transcription as an acceptable part of the analytical process.

Roy's representation of the musical surface is exemplary of first-category transcription: he places graphic signs on a timeline. Such signs correspond to the different perceivable sound entities in the audio signal, and attempt to indicate the moment of the sound attack, the rough length of the sound, its changes in loudness, its relative position and variations along the frequency spectrum (higher or lower pitch). In addition, Roy divides the basic appearance of his signs into three basic categories, which remind us of Fennelly's timbral categories: sound with a recognizable pitch; non-periodic, noise-like sounds; and hybrid sounds, having "both a strong inharmonic content and a recognizable pitch." In the end, then, Roy's graphics conform to our basic intuitions about sound moving in the frequency/time continuum, and take on the most different shapes.

Because of the necessity of showing basic timbral category and loudness, the shapes need to be bi-dimensional, and therefore cannot appear as simple lines. More specifically, there are

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[13] C. Seeger: "Prescriptive and descriptive Music-writing", *Musical Quarterly* (1958) XLIV (2): 184-195

[14] Roy is indeed well aware of the problems hereby discussed. He writes: "Unlike instrumental pieces, acousmatic work is not *a priori* dependent on a pre-existing score for its realization…The listening score is not the work: it is only an 'analogic' representation." Yet, he does not seem concerned with issues of subjectivity: on the contrary! He supports it, as the score is supposed to reveal his own interpretation (first level of analysis) of the music. To this extent, he also makes a point of clarifying that he specifically had chosen not to ask the composer "about his initial compositional intent."

exactly four parameters that influence Roy's drawings:

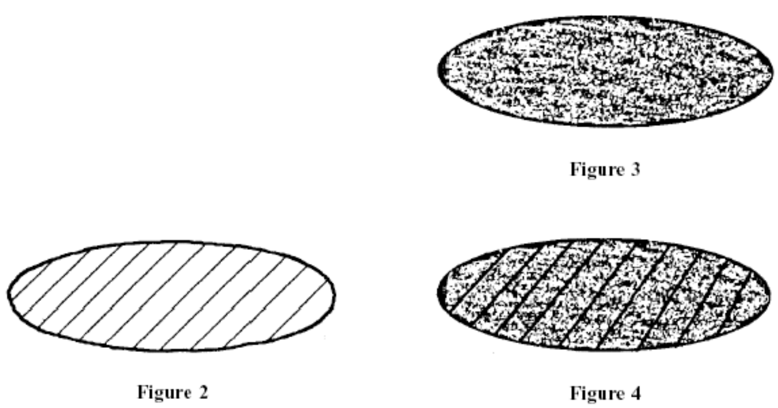
a. sound temporal length, reflected in the horizontal length of the shape.

b. register, reflected in the vertical placement of the shape.

c. loudness, reflected in the height of the shape.

d. mass (timbre), reflected in the fill patterns.

Roy borrows the concept of mass from Pierre Schaeffer.[15] Accordingly, he explains "a sound's mass corresponds to the amount of activity in its harmonic content. A sound which has a dense amount of activity and inharmonic partials does not possess a pitch…A pitched mass is a sound that has a perceivable fundamental and partials that have simple relationships, harmonic to that fundamental." Example 1.3.2 shows Roy's figures 2,3, and 4, displaying model shapes for the three timbral categories.



Example 1.3.2. Roy's fill pattern for the timbral categories: figure 2 applies to pitched sound; figure 3 to noise-like sounds; figure 4 to hybrids.

Roy confirms the intuitiveness of his graphics. "Although the graphic aspect of my listening scores has not been strictly formalized," he explains, "the form of a drawn object

15 More in general, Roy's descriptions of the morphology of sounds in his analyses are all based on Schaeffer's work, as he himself acknowledges. In particular he refers to Schaeffer's *Traité des objets sonores* (1966), and to Michel Chion's *Guide des objets sonores* (1983), which is a summary and clarification of Schaffer's theories.

corresponds to the shape of the sounds." By using the word "shape," Roy refers both to the technical concept of sound envelope (which shows the four distinctive temporal phases of a sound: its attack, decay, sustain, and release), as well as to the intuitive form that a sound project's into the listener mind.

Example 1.3.3 reprints the beginning of Roy's transcription and graphic analysis for *Point de fuite* by François Dhomont. In the example, the straight lines with arrowheads are strictly analytical markings, not intended to be part of the immediate representation of the music. The presence of analytical markings is indicative of the efficacy of Roy's transcription, which in fact allows the author to realize a practical application of his theory, derived from the work of Leonard B. Meyer and later of Eugene Narmour.[16]

Roy's analytical considerations are based on Meyer's "implicative analysis." Meyer's theory was conceived for tonal music, which is openly goal-oriented, but Roy extends some of its basic concepts to all music. Paraphrasing Meyer, Roy states that "the implication is an implicit or explicit hypothesis that a competent listener[17] will formulate, implicitly or explicitly, regarding the past, present and future musical events in a given work. The implication is in fact a hypothesis on the continuation and on the probable realization of a process whose progress has been interrupted." The concept of implication is closely tied to that of "deflection," which consists in the interruption of the process. Deflection causes the implication to arise, and therefore causes tension, which may or may not be released by the "resolution of the

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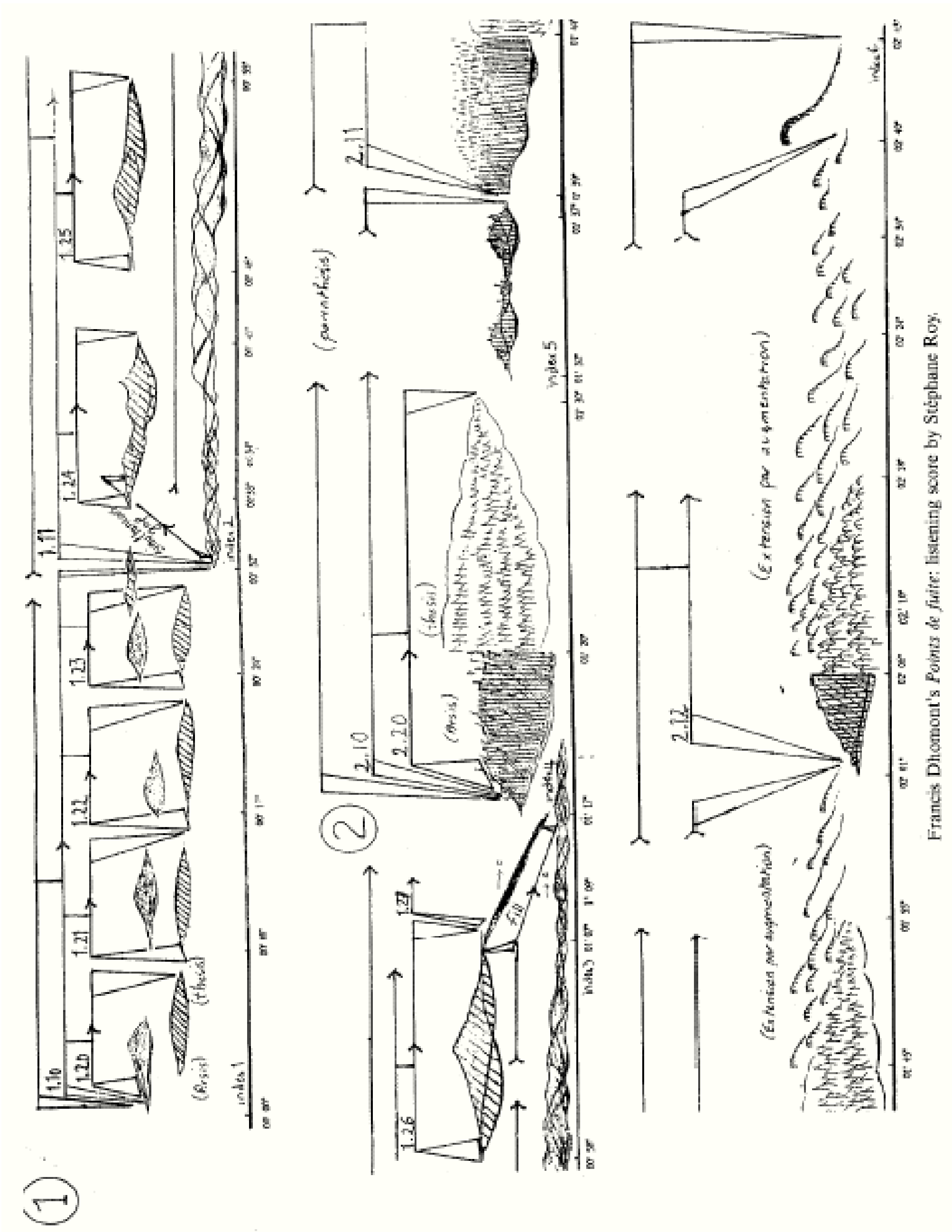
[16] See for example "Meyer, L.B (1956). E*motion and Meaning in Music.* Chicago: University of Chicago Press." and Narmour, E. (1989) "The 'Genetic code' of melody: Cognitive structures generated by the implication-realization model. In *Music and the cognitive sciences*, ed. Stephen McAdams and Irène Deliège. London: Harwood Academic.

[17] Implicative theory assumes the listener to be competent in the style of the given piece. A competent listener can understand the syntactic processes of a work. If these always proceed as expected, then they become redundant, obvious. They become interesting, however, and thus prompt the listener to perceive their possible "implications," whenever they are "disturbed."

implication."[18]



Example 1.3.3. Stephane Roy's transcription and graphic analysis for *Point de fuite* by Francois Dhomont

[18] It is of course less common for us to think of experimental music in terms of tension and release than it is for tonal music. However, Roy believes that "the majority of the acousmatic repertoire can be analysed in terms of tension and release, implication and the resolution of implication. The concepts of tension and release are not exclusively applicable to tonal or modal Western music. In fact, these descriptive concepts transcend style and language; one has only to determine how they are manifested in other musical languages."

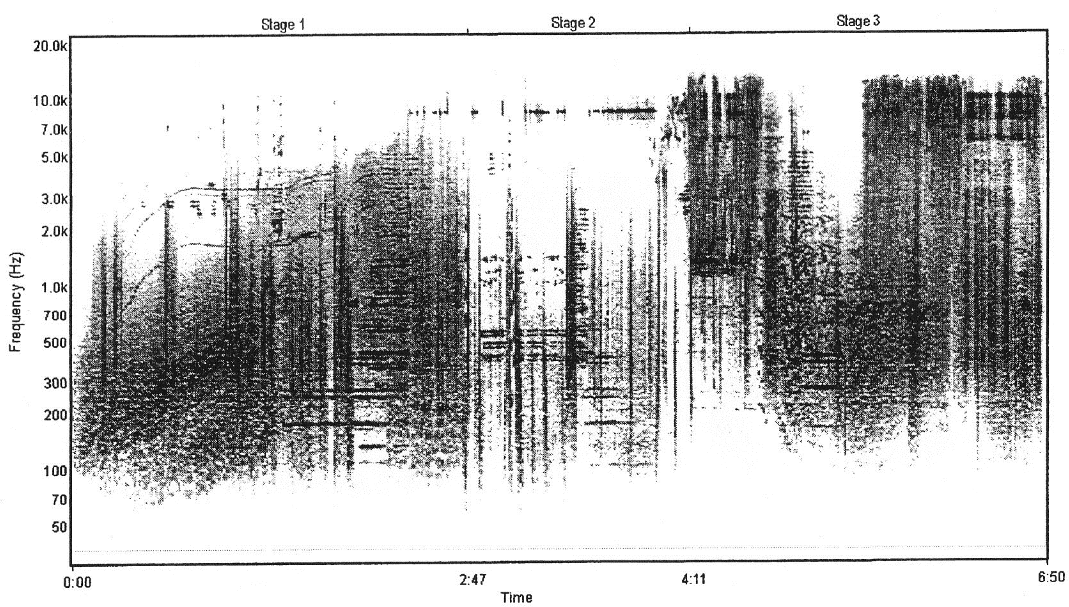
In Meyer's theory, this tension/release, deflection/resolution of the implication model manifests itself in all musical parameters (melody, harmony, rhythm, dynamics, and timbre), albeit in different ways. A typical manifestation for Meyer would be a leap in a melody (deflection), followed by the stepwise "resolution" in the opposite direction. Roy appropriates this manifestation for his method, stating that "in acousmatic music, the leap or gap is not only applicable to the melodic parameter, but to others as well: [...] an event which suddenly becomes dynamically intense can be resolved soon after through a *decrescendo*."

Roy's representation method is particularly interesting because of its simplicity and clarity. It is, unlike Fennelly's method, rather quick, it does not require a great deal of technical preparation, and allows one to apply analytical consideration through visual connection in a much easier fashion. In this it resembles the transcription of music with notes. It is of course more limited than Fennelly's in its possible applications, and far less detailed, but it is systematic enough to promote musical discourse on electroacoustic music and foster a better understanding of the subject matter within the musical community.

1.4 Spectrograms

In the second category we find technically oriented representations. When these are not created by the composer himself (based on the technical data he compiled in writing the piece), namely when they are to be extracted from the sound signal, they are almost always technology-aided, as we have said. In this latter "camp" we find studies utilising the like of waveshape representations and spectrograms. The latter, in particular, are a very popular method of visually representing electroacoustic music. Given a certain sound clip, a spectrogram essentially portrays a diagram-like image of it, in which the horizontal axis represents time and the vertical axis represents frequency. This premise is similar to Roy's intuitive representation. However, here the dimensions are absolute, not relative. For any given moment of the sound clip, indeed, one can observe its exact frquency structure (which frequencies of the audible spectrum are sounding and which aren't). This of course can shed also light on the timbre of a given passage, since, as we know, a certain timbre can be seen as the result of the combination of different partials (i.e., fundamental frequency plus harmonics).

Spectrograms are utilized in a variety of analytical essays. For example, most articles contained in the book *Electroacoustic Music: Analytical Perspectives*, Thomas Licata ed., resort to spectrograms to illustrate some of the pieces' characteristics. Example 1.4.1 reproduces a spectrogram for the piece *Diamorphoses* by Yannis Xenakis, discussed in the article "Diamorphoses by Yannis Xenakis," by Thomas De Lio.



Example 1.4.1. Spectrogram (sonogram) for *Diamorphoses* by Yannis Xenakis (entire piece).

In the article, De Lio shows how, by examining the spectrogram (his Example 2.1), he is able to identify three main "stages of evolution" in the piece (which are indicated on the time axis at the beginning of their occurrence).[19] "In the first stage," the author points out, "Xenakis introduces two contrasting frequency regions and two contrasting sound types. In the second stage, these two regions and sound types are completely separated. In the third and final stage, they are pitted against one another through a pair of sonic inversions. In the first of these inversions, the upper region is emphasized, and the lower one drops out. In the second, the lower region is emphasized, and the upper one drops out. The alternating presence and absence of these regions in stage 3 constitutes the central dramatic dialogue of the piece." (Licata, 2002, 50).

De Lio analytical remarks show us that spectrograms can be useful to make a point about general sonic characteristics of the work, and even, to a certain extent, about the main formal design of the work: through a spectrogram one is in fact capable of comparing passages and finding similarities and differences between their spectral images.

On the one hand, the referential "authority" of spectrograms is not debatable: the spectrogram DOES represent accurately sonic occurrences that reach the listener ears; in this sense, spectrograms leave no room for subjectivity. On the other hand, one could argue that spectrograms cannot be considered fully satisfying representations, in that they present several

[19] Quite interestingly, all those (myself included) who face the challenge of analyzing electroacoustic music are well aware of the problems involved, and feel compelled to discuss them at the outset of their work. This is reflective of course of the lack of a common methodology, and the need of the authors to champion their own choices. We already observed this tendency in Fennelly and Roy. Indeed on page 43, De Lio writes: "In dealing with any electronic work, we must consider the question of how to go about analyzing its sonic events. Typically, there is no score, and each work uses sounds that may be wholly unfamiliar, at least in the world of traditional instrumental/vocal music – a rather narrowly defined sonic environment. With an instrumental work, we study the score, knowing that its notations represent sound. However, in order to deal with an electronic work such as *Diamorphoses* we must develop some way to represent its sonic elements that reveals the nature of those elements, as well as their combinations and transformations, in some useful way. This seems to me to require a new approach to analysis itself…Following the footsteps of a few pathbreaking studies of electronic music by recent scholars, most notably, Robert Cogan, I have chosen to examine *Diamorphoses* with the help of a series of sonograms of a monophonic reduction of the composition."

limitations.

The most important of these is that spectrograms do not always allow one to observe the "polyphony" of a piece (namely to visualize simultaneous, perceptually distinct elements). In this regard, the previously described methods are much more flexible. Additionally, spectrograms do not allow interpreting the spatial placement of a certain sound, which can be an important feature of electroacoustic pieces. Indeed, because their nature is that of describing the audio signal being processed, spectrograms do not always directly relate to what a listener actually perceives: there maybe cases in which the "picture heard" does not seem to correspond with the "picture seen."

In his review of Licata's book, Leigh Landy (2003) criticizes the use of spectrograms and claims that

> "critical texts concerning electroacoustic music […] tend to be written for very knowledgeable specialists, and they tend to be more focused on sonic construction or a composer's theoretical concepts than, say, the listening experience. The first issue is problematic, as it seems to celebrate the fact that the music addressed is one primarily situated within a community of specialists, with little to no impact within the cultural worlds at large…Sonograms [synonym for spectrograms] undoubtedly assist the analyst in terms of demonstrating the structural development of a work as well as a section's general flow, its dynamic, and use of register. What I find troublesome with the use of graphic translation in this volume is that at times the tool seems to lead in providing information to the analyst as opposed to its being used to confirm aurally determined information."

While Landy's position can be considered a bit extreme, it is reflective of an increasing tendency to analyze electroacoustic music from a perceptual point of view. Indeed, several scholars, like Roy, prefer an aural, intuitive approach, and feel compelled to entirely dispose of spectrograms. Some, however, use them in complement with other forms of transcription. This combination of techniques brings us back to the third category.

1.5 *Acousmographe*

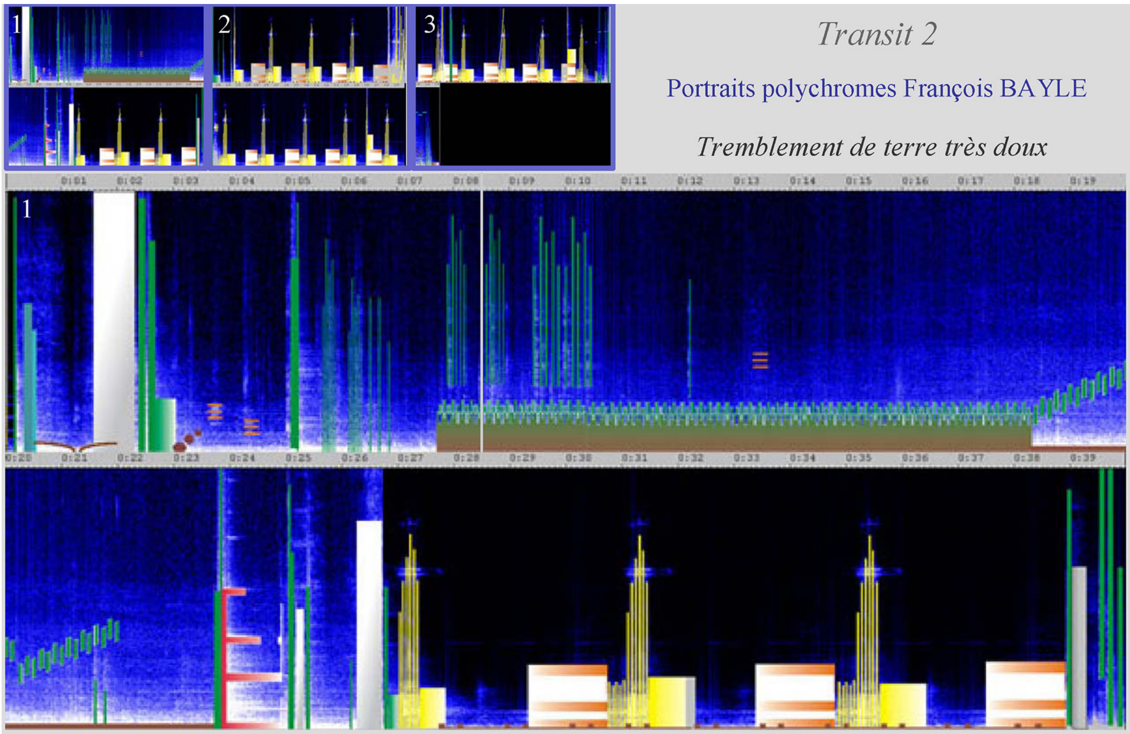
A very popular and recent phenomenon within this category is that of representations realized through the *acousmographe*, found most notably in the *Portraits Polychormes* developed at the *Groupe de Recherches Musicales* (GRM) of Paris, France.

Evelyn Gayou (2006), herself a member of GRM, provides a good overview of the analyses found in *Portraits Polychromes:* "*Portraits Polychromes* are a series of books associated with multimedia documents presented on the Internet site of the GRM since 2001 […] In addition to the heritage value of the GRM's collection, the enterprise of the *Portraits Polychromes*, with the aid of multimedia tools, aims to advance the progress of research on the analysis and the transcription of musical works." Indeed, within the *Portraits Polychromes*, we find many attempts at representation, the most peculiar of which being realized through the use of GRM's own tool called "acousmographe."

The *acousmographe* is a software built with the purpose of realizing third category representations. It works by creating a spectrogram of the sound signal (it could be of the entire piece or a small section of it, at the will of the user) and then allowing the user to "draw" upon the spectrogram, so to complement the machine's results with one's own intuitions. While providing a constant comparison term with an objective portrait of the signal, the *acousmographe* allows one to choose what type of approach to take in his graphic complement. The retention of such "diversity" in representations is a very important element for the GRM. As Gayou puts it "each transcription addresses different musical concepts that enable us to articulate in a clearer manner. Each transcriber is free to find the figures which harmonize the best with his/her perception." Among the diverse representations in *Portraits Polychrome*, indeed, we find those that “are oriented towards a graphic transcription of the sonic space, while other apply themselves to explaining the composer’s musical rhetoric.”

Another GRM warhorse is the *necessity* for graphics in the representation of electroacoustic music. This is reflected in the fact that some of the representations are done in collaboration with graphic artists. For Gayou, the concept of representing through images, the concept of “pictorial thought,” “leads us towards the deep layers of our sensations, very likely related to our first sensory motor experiences, memorized […] since childhood.” And again, “the idea of image, appropriate to the functioning of perception, appears as a point of convergence between reality and representation.” This is in accord with the idea of sound being treated as image, a very common aesthetic among electroacoustic composers. Francois Dhomont, the composer analyzed by Roy [see above], explains (as quoted in Gayou, 2006) that “this sonic art often compared to the cinema, allows for the discovery of acoustic territories which instrumental composers have left behind as a fallow field; oscillating continuously between truth and mirage, it feeds itself from the strength and the ambiguity of the image.”

An example of transcription through the *acousmographe* is found in the part of the *Portraits Polychromes* dedicated to the composer Francois Bayle. The transcriber Simon Rusch takes the spectrogram of the piece *Tremblement de terre tres doux*, and superimposes his own idiosyncratic graphics, often in different colors, to clarify the spectrogram, so that one can instantly recognize in it the sound events as perceived from the recording. The criteria for the graphic clarification are clearly expressed at the outset of the analysis, making the representation very easy to follow. Example 1.5.1 includes a segment of the representation and some of Rusch’s criteria (colors are of course ‘lost in translation’).



Ex 1.5.1. Rusch's representation of Francois Bayle's *Tremblement de terre tres doux* (excerpt) through the use of the software "acousmographe." Examples of the reading criteria are as follows:

> - Yellow bar: a 'click-sound' (high and short), which cannot be heard properly. This is why I have chosen a bright color and a narrow shape.
> - Brown block: the symbol starts with shades of grey and white, until the sound becomes louder, clearer and more intense. For this reason I have chosen brown as the target color. The sound ends abruptly, like someone was slamming a door (this is indicated by the little green bar at the end of the symbol).
> - Long green bars: symbolize the chopped structure of 'clack-sounds'. A lighter shade of green describes a higher frequency.
> - Narrow pink bars: derived from the green bars. They also signify the 'clack', but here it occurs much softer.

Because this method is backed by scientific evidence, it provides greater detail concerning the sonic structure of the work: the quality of specific sounds, and their distinct character is displayed in greater detail then in Roy's method, but at the same time the graphic aspect saves Rusch from Fennely's bulkiness.

The *Portraits Polychromes* offers in effect a good combination of subjective and objective data. However, the method is not bereft of limitations. Because it relies heavily on spectrograms, it also fails to provide a clear picture of the polyphony of the pieces in analysis: even if it does highlight specific sounds, it is never all of them. Moreover, it does not provide a clear picture in terms of the evolution of specific sounds over time.

1.6 Conclusion

In general, all the transcription methods that I have described seem to suffer from the same problem: they do not allow the reader, especially if he is relying solely on his musical background, to get a clear idea of what the piece sounds like. Once the reader listens to the piece, then all of the above transcriptions do help in shedding light on some elements of the piece's structure and the sounds' morphology. Nonetheless, the distance between perception and representation is significant, and interferes with the analytical endeavor.

In the following chapter I will try provide a possible solution to the issue. I will present my own method of transcription. This will take into consideration the most fruitful elements from all of the above, but it will also introduce new strategies in the attempt to provide an immediate score-like image of the sonic output to the analyst. The proposed method should allow performing a variety of analytical investigations on the pieces under examinations, and should show how such electroacoustic pieces can be interpreted in ways that are not incompatible with other musical repertoires. I will start by transcribing and analyzing *Audible Ecosystems 3b*, by Agostino Di Scipio.

Chapter 2
Transcription and Analysis of *Audible Ecosystems 3b,* by Agostino Di Scipio

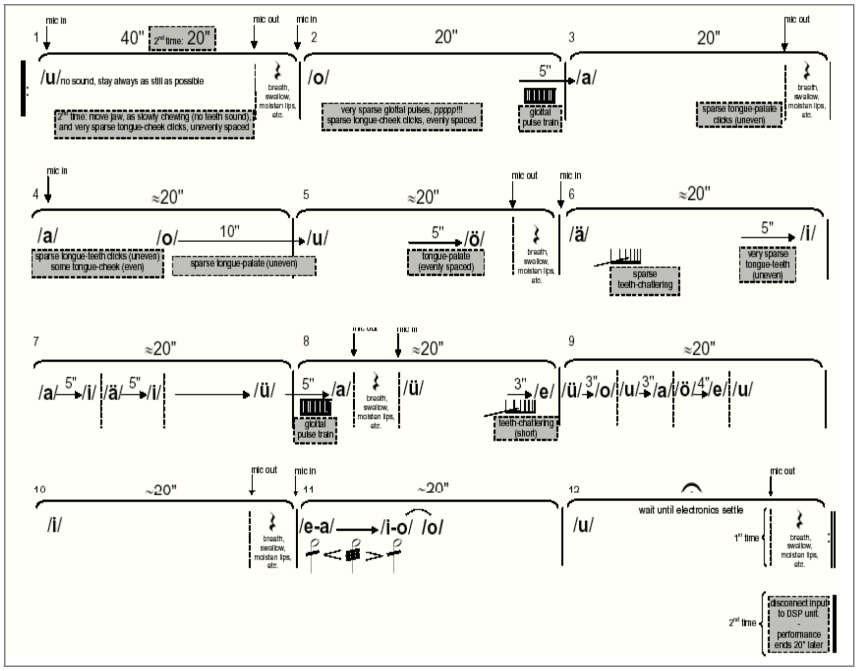
2.1 Introduction

Audible Ecosystems 3b, by the Italian composer Agostino Di Scipio, is an electroacoustic piece. It is a piece for vocal performer with electronics, devised so that the exact outcome of the performance, i.e., the structure of the "heard," the sonorities created, its rhythm, etc., are largely unpredictable prior to the performance itself. This is because the piece is meant to behave as a "non-linear dynamical system," i.e. a system that more or less radically changes profile over time due the variations that occur in its initial state. Therefore, every single performance of the piece will result in a sonic experience that will differ perceptably from that of any other performance. Unlike an aleatoric piece, however, the result is not "random" in the sense that it depends on undetermined human behavior (or at least it is no more so than any piece of classical music), but follows instead very specifically from the predetermined (programmed) structure of the process; the only non-controllable element in the process is the initial condition ("initial" meaning at the beginning of each process, rather than the beginning of the piece).[1] Non-linear dynamic systems like this are also known as "chaotic systems," where the word "chaos" signifies a state of, if only apparent, lack of predictability with regard to the system's long term behavior. High susceptibility to initial changes is a necessary condition for a system to be related to chaos, one that is shared by many natural phenomena, such as the weather.[2] Inspired by the desire to

[1] The scenario is in fact quite opposite from certain "aleatoric" pieces, in which the initial-conditions are the only known element of the process.

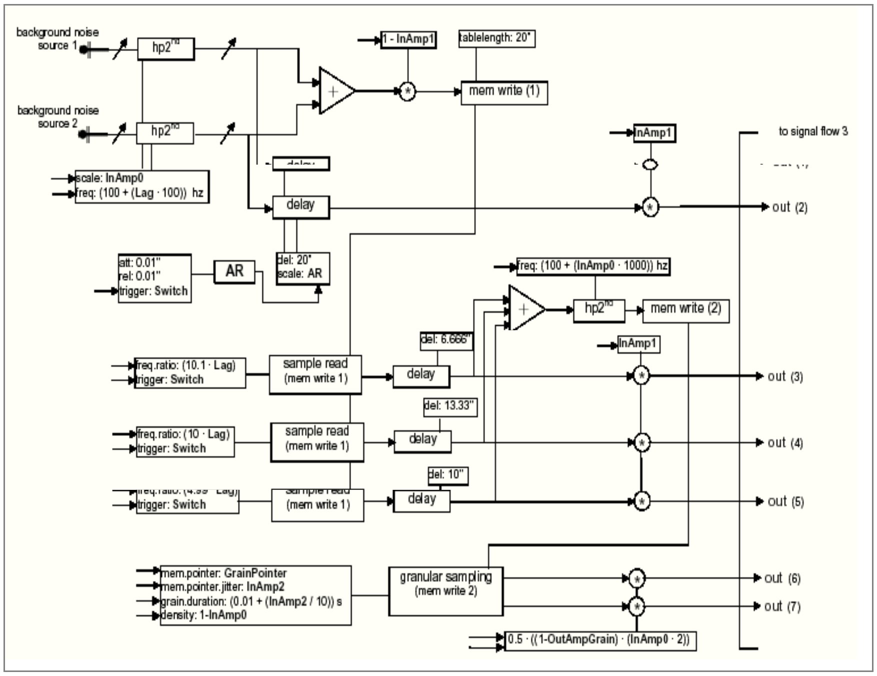
[2] "High susceptibility to initial changes" is a characteristic more commonly known as "butterfly effect", a term taken to exemplify the susceptibility and resulting long-term unpredictability of the weather (in which a seemingly "innocent" event as the flapping of a butterfly's wings in a certain part of the planet may ultimately cause a significant weather change in a different part of the planet. Although this example is hyperbolic in nature, it is meant to illustrate the impossibility of predicting the weather accurately due to the impossibility of knowing all initial conditions).

recreate a natural system of this kind, in *Audible Ecosystems 3b* Di Scipio explores the sonic possibilities of the human vocal tract by manipulating the "sound environment internal to the … mouth" and the room background noise through a process that exhibits chaotic characteristics.



Example 2.1.1 The performance score for Di Scipio's *Audible Ecosystems3b.*

The performance score for *Audible Ecosystems* (presented in example 2.1.1) only includes directions for the performer to execute specific behaviors, rather than displaying a more or less exact representation of the sonic outcome. However, since the piece involves electronic equipment, the composer also provides a detailed description of the electronic manipulation process. These essentially reveal Di Scipio's compositional procedures: what is the process that will determine the experience of the piece, and how does it work. In the notes to the performance score, Di Scipio clarifies right away the "chaotic" nature of the piece, by explaining how the work "consists in the implementation of a real-time process capable of regulating itself dynamically." Such real-time process is amply illustrated in three signal flow charts describing the "network of control signals", the "audio processing for sonic transformations of the input sound (shown in Example 2.1.2), and the routing of the output sound to the loudspeakers."



Example 2.1.2 Audio processing signal flow, from Di Scipio's *Audible Ecosystems 3b* score.

Following the charts, Di Scipio proceeds to a verbal "description of the system process," which is crucial to understanding certain basic traits of the sonic output. "Performance," the author writes, "begins by starting the DSP unit. There is first a silence of 20 seconds, and then the source background noise heard in the loudspeakers and starts recirculating in the 20-second feedback line. When the level of tiny random events…exceeds a given threshold, or the sound in the feedback loop accumulates to finally exceed that threshold, audible changes in spectrum coloration and space orientation of the delayed sound take place in the DSP unit. At all time the input sound is recorded into a 20-second memory buffer, but only when the threshold is exceeded, the DSP unit starts reading samples off the memory buffer, producing (rather heavy) transformations of the input. When the threshold is repeatedly or permanently exceeded, the Dsp output grows louder and denser, and the delayed input sound is automatically shut down, thus discontinuing the feedback loop, too. Sooner or later, the sonic transformations will build up to point of saturation. When that happens, the process shuts itself down, and automatically restarts within the next 20 seconds…with each new start a different behavior is likely to emerge….The full performance consists in several runs of the above process…"

The composer also provides a brief but significant display of his awareness of the characteristics of the sonic output. "The DSP output sound consists in textural or gestural transformations of the input material. The result may be rich in clicky artifacts, interferences and other transient phenomena. In case the process reveals itself as relatively idle, the 20-second feedback loop will let some frequencies […] become stronger than others, and they will add pitch variations and glissando gestures to the output sonority."

This description provides us with a fairly good overview on how the piece is put into effect, and gives a preview of what to expect: the 20-second time units, the clicky artifacts, the interferences, the glissandos, are all elements that one very much experiences when listening to *Audible Ecosystems.* As we said, however, the piece, as a non-linear system, is so dependent on the input sound that in no way can we predict the final structure. So when it comes to analyzing the piece, we have essentially three choices:

1. To discuss the so called poietic dimension: this in this case would be somewhat redundant given the detailed description of the process provided by the composer.
2. To provide an analysis of the aesthesic dimension, that is, basing the discussion on the listening experience, on the sonic output, rather than the compositional procedures. In this case we have to be aware of the fact that every performance of this piece will provide a significantly different performance experience, and therefore a different transcription

and analysis, even though obviously some common traits will be displayed.

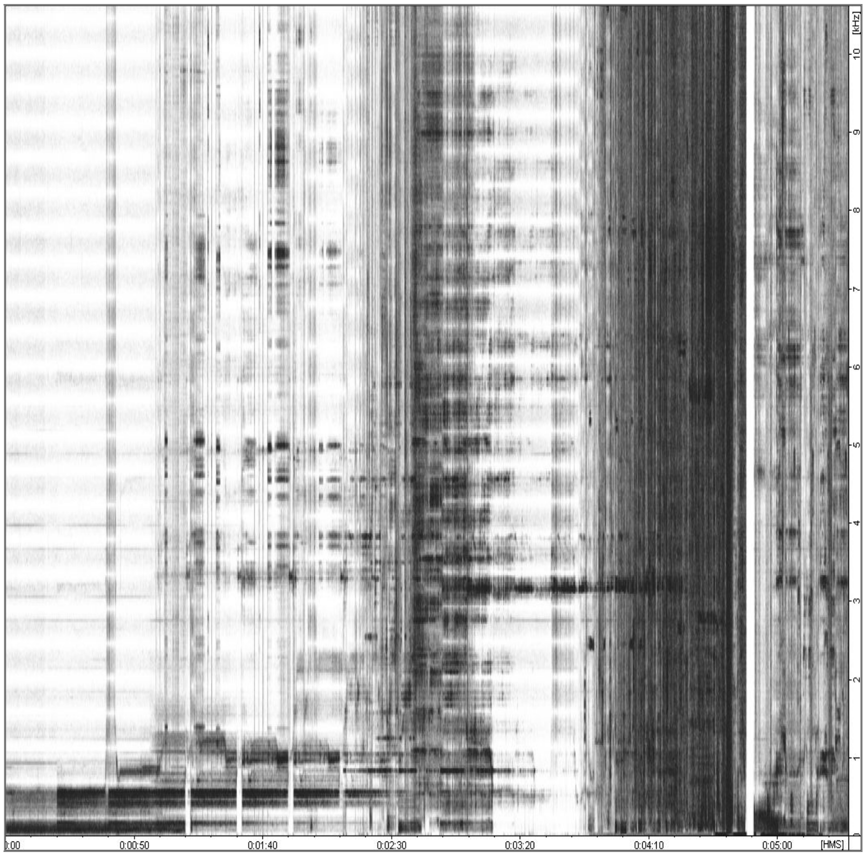
3. To provide a cross-analysis of two different performances, to illustrate the different behavior of the system when stimulated by different conditions.

This chapter will focus on “b,” since it is particularly interesting to observe what kind of musical structure the system is able to give life to, and since “c,” even if desirable, is currently impossible given the fact that presently only one official recording of this piece exists.

2.2 Transcribing *Audible Ecosystems 3b*

The first step in this analytical venture is that of providing a meaningful transcription of the work, a good way of illustrating schematically the sonic flow of this performance. Like all transcriptions, this will already have in itself an analytical stance, since it will inevitably contain a certain degree of subjectivity, and will tend to highlight certain traits of the piece.

I personally favor methods of representation that combine scientific data with intuitively derived information. In transcribing Di Scipio’s piece I first realized a spectrogram of the piece (example 2.2.1) with GRM’s software *Acousmographe*. This allowed me to evaluate certain parameters with exactitude, and most of all with a certain ease: the position of certain sounds along the time continuum, their position along the frequency continuum, and their spectral characteristics. In a spectrogram, however, sound events heard as separated are often hard to separate from the global image, or vice-versa, events heard as single sounds can appear as the layering of different elements. For this reason it is important to sketch a score which mirrors our intuition more closely.



Example 2.2.1. Spectrogram for the first half of *Audible Ecosystems 3b*. The x-axis represents time, while the y-axis represents the frequency domain. Darker traits correspond to louder sonorities.

Indeed, while observing the spectrogram, I repeatedly listened to the piece to assess how many different sounds I was able to discern.[3] I then listed them and named them according to their potential “source-bonding,” to onomatopoeic criteria, or when the former options proved impossible, according to “formal” criteria similar, albeit simpler, to those of Fennelly (see Ch.1).

Borrowing the term from Denis Smalley (1994),[4] by source-bonding I intend associating

[3] In a piece such as this, we cannot know for sure how many different sound objects (auditory stimuli perceivable as separate phenomena, as coming from different sources) are present; it really depends upon the listener, and on how the listener is listening, besides the fact that some sounds maybe the byproduct of the “union” of two or more different sounds, which, once united, cannot be told apart (a process known as “fusion” in psychoacoustics). The issues here are indeed many, but my “technique” responds to a very basic, primal instinct, which is that of identifying elements that we perceive as being different at any given moment, regardless of the fact that, since we can not see them or hear them, they may be composed of smaller independent elements (e.g., let us think of a digital picture and the tiny pixels that it contains).

[4] Smalley, D. “Defining Timbre, Refining Timbre.” *Contemporary Music Review* Vol. 10, Part 2. London: Harwood, 1994

a certain sonic event to its producing source (e.g., the sound of the wind to the wind) whether real or imagined: the word "potential" is added because the sources are sometimes determined by an instinctive association, meaning that the sound only resembles that of its source[5], presenting some common traits that are strong enough to induce the connection, but without necessarily mirroring the original exactly as it appears in our conscience. Source bonding seems to me as a very natural strategy, in that is something that listeners can hardly avoid doing (unless they make an effort not to) when confronted with a sound that reminds them, to a greater or lesser extent, of a real life situation. Indeed, Michel Chion (1983) even goes as far as suggesting that a source (the "thing" that produces the sound, as he calls it) is always looked for, even for those sounds that seem to have no connection to real sources at all.

In some cases, when the sound seemed to connect to a real-life object that could produce different sonorities depending on its use or condition, I added onomatopoeic labels**:** the same principle utilized in naming various musical instruments, particularly percussion (e.g. the "crash" cymbal); this principle obviously attempts to express how the sound would be like if one tried to mime it with his voice, to provide an immediate reference to the reader.

In few cases, when the sound would not inspire a true real-life connection, even an onomatopoeic label may provide little help, mostly because such label would simply be too generic, not representative enough of the sound's characteristics. In such cases I added a simplified Fennellian string such as: **"AX|>"** where value A describes the sound's pitch quality (A=pitched; B=somewhat pitched; C=unpitched/noisy), value X describes the sound's behavior in time (X=sustained; Y=fragmented;[6] Z=pulse), and the following symbols describe, for

[5] In other electronic music pieces of course the association is much less vague, as sounds are clearly taken directly from real life.

[6] By "fragmented" I mean sustained but not stable, i.e., perceivable as one long sound object, albeit with texture destabilized by rapid changes in pitch or loudness (e.g., an instrumental tremolo).

sustained and fragmented sounds, the sound's attack (|=fast; <= slow) and release (<=crescendo; |=sudden stop not preceded by changes in loudness; >= decrescendo).

Although my system of identification may be subject to heavy criticism for its non-scientific grounds,[7] it seems to me that its simplicity, its ability to concisely (albeit roughly) provide a description of certain spectral characteristics of a sound, to immediately stimulate a sonic image in the mind of the reader, and to adapt to a large variety of music make it worth pursuing. In addition, this method is not meant only to serve the purpose of quick identification; it does not in itself impose any critical or aesthetic judgment on the piece observed.[8] [9]

In *Audible Ecosystems* I was able to identify 20 distinct sound-types: these are presented in the following list, which alongside the labels contains a verbal description of the sounds' characteristics. Such description is very important, as it helps the reader to get a better image of sound described.

1. "Fridge." Low sustained hum typical of motorized appliances such as a refrigerator.
2. "Mic thud" (or in short "thud"). Short unpitched low hit reminding of a performer

[7] As we have seen in ch. 1, both Pierre Schaeffer and Fennelly made strong cases to promote recognition and labeling of sounds based on their morphological characteristics; on objective, pre-defined criteria that could include any possible hearing experience, rather than on intuitive, associative ones. It is, in effect, an approach quite different to mine: detail vs. general, literal vs. metaphorical, systematic vs. flexible.

[8] This transcription lends itself particularly well to the analysis of pieces that, as in Di Scipio's case, reach their final output through the use of natural sources (in this case: the human vocal trait, the room noise…etc) rather than through fully synthesized sonorities. In the latter case, potential source bonding may result more challenging, and onomatopoeic or "formal' labeling will provide a viable help. In cases in which the piece is composed through mixing of different existing elements, as it is the case of composers working with sequencing software, it can be of great help to examine the sequencing session, resulting in a faster transcription, as we will see.

[9] On the other hand, if the purpose of certain pieces is, as some argue, that of "transforming" sound, of smoothly evolving sonorities from one starting point into the next, how can the identification of sonic objects become a fruitful method for analysis? If the point of a piece is not "arranging" objects, but transforming them continuously, what is then the point of fishing for objects that can be revealed only as in continuous transformation? The answer to this question depends from one's approach to the topic. I personally believe that even in the most extreme cases, there is always the possibility of examining the beginning and ending state of one transformation, pinpointing the two different states, to then observe what kind of transformation led to the change of object. At the same time, identifying sound object in an electronic piece does not mean establishing the fixed "instrumentation" of the piece: it neither means that those sounds will remain the same throughout the piece, nor that they will change. Depending on the type of piece, one should attempt to comprehend the "function" of timbre in that piece and tale it in consideration in his analysis. In any case, to quickly identify certain sounds in a piece maybe useful no matter what kind of musical analysis we are trying to entertain.

accidentally hitting a microphone.

3. “Mouth.” This is more of a category than a single sound. I group here all the sounds that appear to be generated within the vocal trait through common acts such as chewing, swallowing, opening/closing mouth, producing saliva, breathing etc… In this case the source bounding maybe considered objective, since as we know that the piece is performed with a microphone placed in the performer’s mouth. Depending on the performer’s activity the “mouth” sounds may appear more or less sustained.
4. “Click.” Short, soft ticking sound.
5. “Noise.” Related to click and mic thud, as they are both unpitched (inharmonic) sounds, but often sustained, with the typical hiss-like texture (i.e. a TV static). Sometimes, it assumes a more “metallic” quality or a more “liquid” quality, which in the latter case brings it close to the sound of frying oil.
6. “Water Tube.” Sustained, somewhat pitched sound similar to water running through a metallic tube. Related to fridge, but with higher frequency.
7. “Cricket.” Tremolo-like, high, sustained sound associable to a cricket’s chirp.
8. “Wood crack.” Associable to the sound of a piece of wood being cracked.
9. “Glass.” High-pitched sound associable to that produced by sliding a finger over the edge of a glass filled with water.
10. “Plastic tick” (or in short “tick”). Similar to “Click,” but reminding of plastic material, as a pen’s cap hitting the surface of a table.
11. “Plastic snap” (or in short “snap”)Seemingly generated but quickly extracting a cap from its pen.
12. “Whip delay.” Similar to a whiplash with applied delay (short echo).

13. “Record crackle.” Sustained crackling sound, sometimes interchangeable with “noise” (in its most “clicky” manifestations). Associable to the typical background sound of a vinyl record being played.
14. “Mouse.” Squeaky, mouse-like sustained sound.
15. “Bag shake.” Short repeated, tremolo-like sound, as if one where to shake a bag filled with small plastic or metal objects. Similar to a “plastic tick” tremolo.
16. “Slow record.” Sustained, sweeping low sound, typical of musical records being played at a speed slower than normal and inconstant.
17. “Digital explosion (CY|>).” Swift noisy outburst, fragmentary, with fast attack, and fast release. One should imagine a plethora of simultaneous digital glitches such as those heard in digital audio media.
18. “Whoom low” Low sound associable to a violent air blow into a large tank. Loud but swift, with a reverberation that makes it trail off smoothly.
19. “Water pour.” Associable to water being poured from a container into another.
20. “Steps Reverb.” Sound of footsteps, with much reverberation.

Once I identified sounds based on the above criteria, I compared my findings to the spectrogram, to isolate the parts that corresponded to the sounds I had listed. In some cases this was rather easy, in others quite hard. This was done so that I could eventually organize them on the score based on their relative position on the frequency domain. Quite intuitively I assigned the lower positions to low register sound, and, vice-versa, the higher positions to high register sound. I kept middle register sounds, and sounds that occupied rather wide frequency bands (i.e. “noisy” sonorities) toward the center of the transcription.

The result is a “score” that is similar to score for unpitched percussion instruments, where each staff is composed of one line. The notation is graphic, and is inspired by Stephan Roy's notation as described in the previous chapter. I use straight vertical lines to indicate brief, pulse-like sonic events; I use larger X signs to indicate more significant short events (louder, or in some ways more prominent). I use horizontal lines to display sustained sounds that are pitched, or in this case that have a hint of a pitch; I use zigzag lines to express unpitched sustained sounds. Information on timbral characteristics of the sounds is then almost only contained in the label, as described above. The position on the frequency domain is approximate and so is the position in the time domain: in the frequency domain I tend to notate sounds on the staff unless they are clearly higher or lower than first heard, in which case notate them above or below the staff; in the time domain I notate them with an approximation of about one second or less with respect to their actual position on the time continuum; sometimes, when a brief sounds repeats quickly and chaotically, I also approximate the number of repetitions, as it is almost impossible and often irrelevant to count them exactly. In this case the approximation in the time domain of the repetitions can also be larger then one second.[10]

Indeed, as most examples of graphic notation, this is an "approximate" transcription, but it gives a fairly decent picture of what happens sonically in the piece: what are the main sound events, and what is their behavior over time. To make things easier on the reader, I divided the scores in 20-second measures, which of course have no metric value,[11] but only serve the purpose of orientation; I chose 20 seconds as this is the amount chosen by the composer when "measuring" the performance score for the vocalist, in reference to the 20-second memory

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[10] The idea is that when we hear a sequence of fast-repeating, chaotically-distributed pulses, it seems irrelevant to identify the position of each of them. Rather, one should try to identify clearly the beginning of such sequence and its end.

[11] As a score made for reader with musical background, the idea is to make it as musician friendly as possible. In this sense I refer to measures, even though the term never has the metrical implication it bears when used in classical notation. 'Measures' here refers to the idea of segmenting the score in temporal unit that can be more easily managed than one giant temporal unit.

buffers which are used in the system process. Indeed, we will see how often important events will occur in the vicinity of the proposed barlines, thus making it a feasible choice even if one were to disregard the composer's indication (to avoid been influenced during the listening process).

Example 2.2.2 shows the last version of my transcription of the first part of *Audible Ecosystems 3b*. When it comes to analytical considerations on the piece, based on the observation of my score and of the spectrogram, we are able to define several distinctive features in terms of formal, gestural, and sonic (timbral) behavior.

I will approach the analysis as follows: at first I will provide a step by step account of the score, so that the reader will be guided in understanding how to follow my transcription method. This will result in a quite extensive account of surface/foreground information. The surface account will then lead to the next part of the chapter, which will demonstrate how different analytical techniques can be applied to *Audible Ecosystems 3b* through the transcription, and how these can allow one to make larger-scale connections that will ultimately reveal important, otherwise difficult to visualize structural features of the piece. To make an example, we will start by noticing how the piece is divided in a series of apparently unrelated sections, to later reveal how it is actually organized as a binary form.

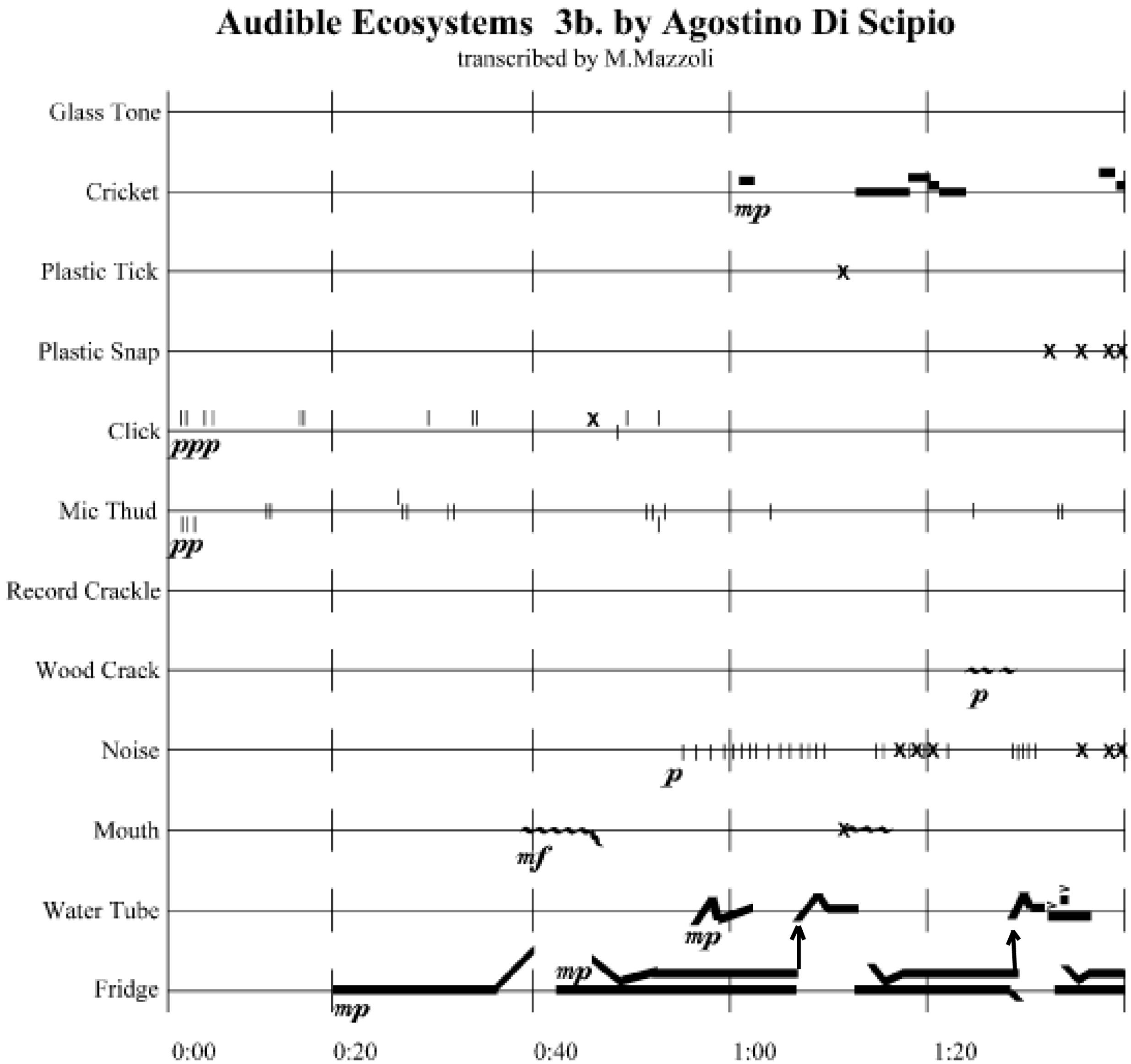
2.3 Reading the Transcription. The first part of *Audible Ecosystems 3b.*

As we listen to the piece, due to the strong breaks it contains, it becomes apparent that it is divided in 2 main sections, each of which can be divided in three subsections. The first subsection functions as a sort of introduction, whereas the last subsection is a sort of coda.

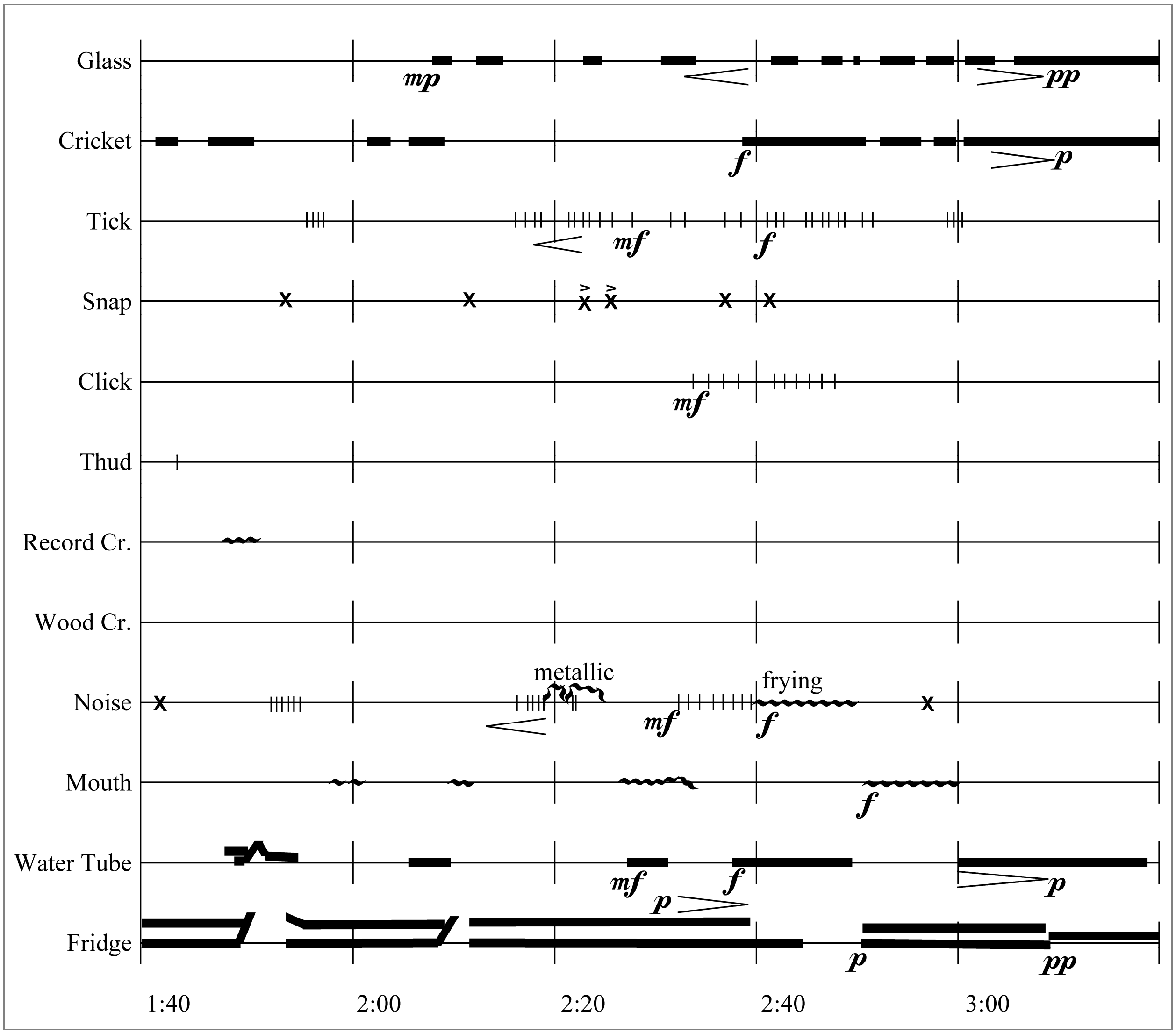
Generally, because of the accumulating feedback, which tends to lead to saturation and eventual momentary “collapse,” as the composer himself explains, each subsection has a similar structure: starting from a “lighter” texture, it tends to get denser and louder: as each section proceeds, sonorities accumulate in quantity and loudness until the point of saturation. The following outline summarizes the formal architecture of the piece. The basic traits of this initial formal outline can be nicely visualized in the spectrogram. Indeed, in Example 2.3.1 the various subsections are highlighted over the piece’s spectrogram:

- Section I (0:00 - ~4:50) mm. 1-mid 15
- Intro: mm.1-2 (0:00-0:40)
- Subsection A: mm.3-mid 11 (0:40 – 3:30)
- Subsection B: mm. mid 11-mid 15 (3:30 – 4:50)
- Section II (4:50- END) mm. mid 15–25)
- Subsection C: mm. mid 15-mid 20 (4:50 – 6:30)
- Subsection D: mm. mid 20-25 (6:30 – 8:09)
- Coda: m. 25 (8:09 – END)

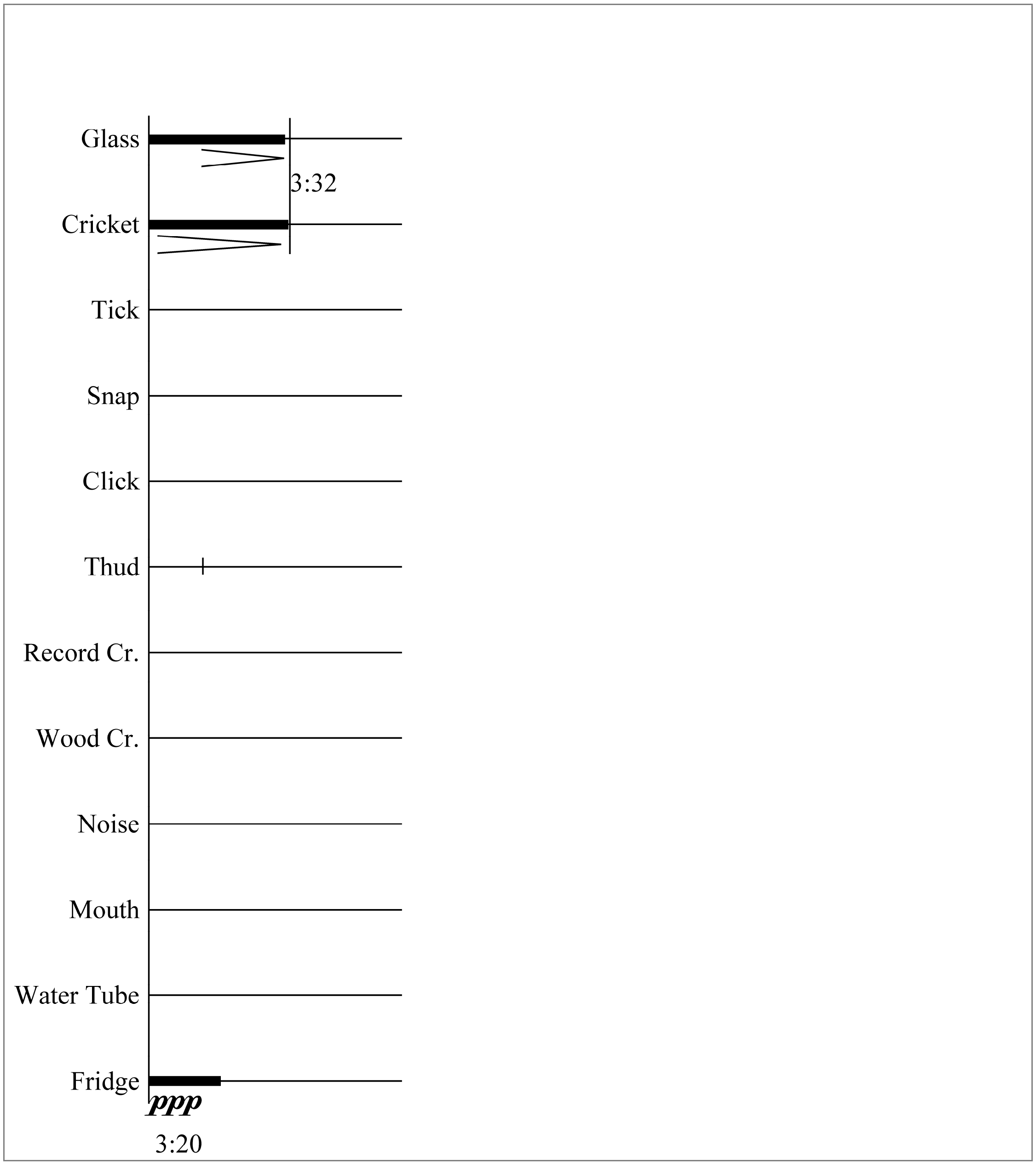
The introduction lasts about forty seconds, the span of measures 1-2 in the score. In this part the music is very delicate: few sounds appear, and sparingly, allowing us to perceive every detail fairly clearly. The principal sound to appear in this section is “fridge”: one the main sounds of the piece, which is indeed a “background noise study,” is seemingly provided by the background noise of the room and of the performer’s mouth. Because of its nature, when it is present “fridge” functions as a sort of low pedal, and gives a very distinctive tone to the passage.



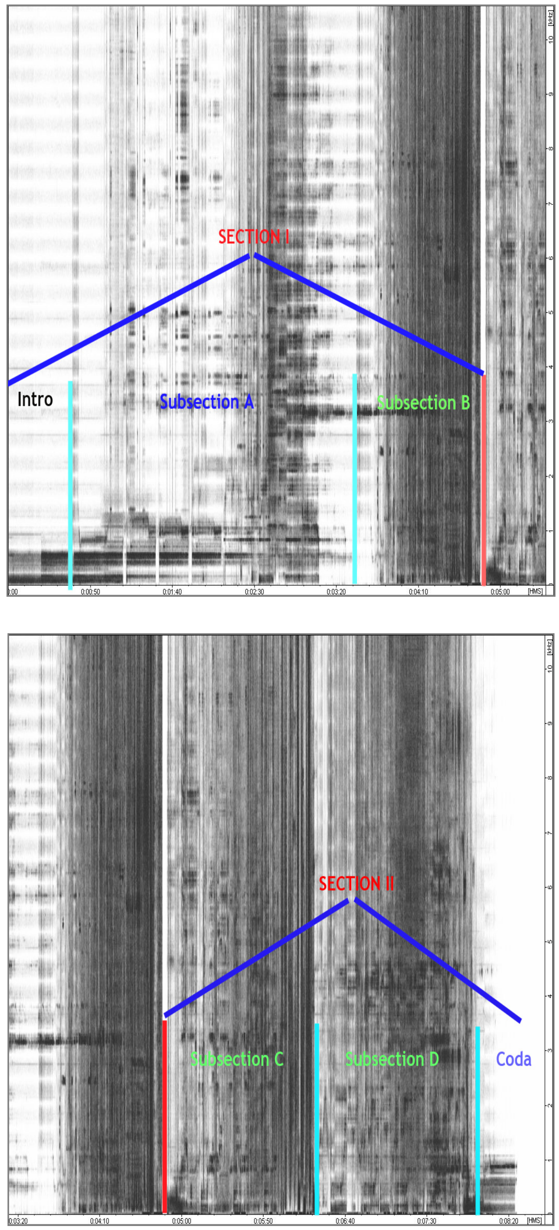
Example 2.2.2. The transcription of the first two subsections (Intro+A) of Di Scipio's *Audible Ecosystems 3b.*



Example 2.2.2. The transcription of the first two subsections (Intro+A) of Di Scipio's *Audible Ecosystems 3b* (cont'd).



Example 2.2.2. The transcription of the first two subsections (Intro+A) of Di Scipio's *Audible Ecosystems 3b* (cont'd).



Example 2.3.1. The form of *Audible Ecosystems 3b* highlighted over the piece's spectrogram.

Besides "fridge" in the introduction we only hear sparse instances of "click" and "mic-thud," which are probably derived from the microphone bumping against or touching the inside of the performer's mouth. In a piece like this, which exists in close connection with the surroundings, feeding itself from every sonic event manifested around the microphone(s) (whether voluntary or not), these sounds cannot be considered unwanted technical imperfections (as it could be in an instrumental piece), but they are an integral part of the music. During the first twenty seconds of the piece we hear an alternation of these two short sounds, almost creating a rhythmic pattern. As “fridge” enters after 20 seconds, louder than the other two, “click” and “mic-thud” keep alternating so that they break its stability and anticipate a typical feature of the first part of the piece: the constant “confrontation” between fridge and other sounds.

The first clear “statement” in this direction is provided at the end of the introduction, around 38 seconds into the piece (between measures 2 and 3 in the score). At this point “fridge” quickly rises in frequency in a glissando that seems to lead to the entrance of “mouth,” the loudest sound so far. The upward glissando of “fridge” is a recurring gesture that anticipates the entrance of another sound, and generally closes statements by “fridge.” This is most likely a result of the fact that in these instances the performer is moving her jaws to follow the composer’s indication, therefore changing the size of her oral cavity to accommodate certain vowels, and thus provoking a change of frequency in the background noise of the cavity itself. It is an element of connection between the performance score and the sonic outcome.

As we said, “mouth” is more of a category than a single sound: it refers to recognizable activity coming from the oral cavity, encompassing a variety of sounds (moistening, swallowing etc…). It may appear as sustained not as characteristic of a single sound-component, but with reference to the duration of the mouth’s activity for a certain time-span. In this sense “mouth” at the beginning of measure 3 “lasts” for a few seconds, even though it consists of several recognizable shorter sound-units (i.e., mouth opening, chewing, mouth closing). Right after the beginning of mouth, “fridge” appears again. However, as “mouth” disappears at around 45 seconds, fridge picks up mouth's lead introducing a new sustained tone, which comes in with a downward glissando: a result of the closing of the mouth contrasting the opening at the end of measure 2. This new sustained tone is higher in frequency than the previous, and coexists with it, thereby revealing a "polyphonic" nature for "fridge."

The section initiated by "mouth" is the longest within the piece, lasting for almost three minutes, and introduces the most important sounds of the piece. Indeed, after a few more instances of thuds and clicks, "noise" appears towards the fifty-sixth second (m.3). It is not sustained, however, but consists of brief scattered instances.

Right after the appearance on "noise," the next sound to appear is "water tube." This presents a close affinity to "fridge." It is indeed very close in timbre to "fridge," excepting the fact that it occupies a higher frequency band, which probably provides the "running water" impression. Like "fridge," "water tube" is often characterized by glissandos and changes in frequency, especially in its first appearances. Between measures 3, 4, and 5, "water tube" appears three times with a very peculiar gesture: an upward glissando is immediately followed by a downward one, albeit shorter, before stabilizing into a sustained tone.

The affinity between "fridge" and "water tube" makes them at times hard to tell apart: towards the half of measure 4 when '"fridge" stops again to make way to another instance of "mouth," an upward glissando is heard in "water tube," which could also be interpreted as part of "fridge," hence the arrow in the score between the two parts.

Shortly after the one minute mark (m. 4) a new sound enters, "cricket." Cricket is generally a fairly stable sonority, although sometimes it moves across the frequency domain. Particularly in its first instances (mm. 4-5), it has a tendency to slide downward, as to counteract the upward glissandos in the other sounds.

Measures 6 and 7 witness the "cameo" of two sounds: "wood crack" (m. 5) and "record crackle" (m.6). Both are short creaking sounds that appear in conjunction of a "fridge's" stop, emphasizing it as prominent punctuation mark within the musical discourse.

Of the last three sounds to appear in subsection A, two of them live in close symbiosis: "plastic tic" and "plastic snap." Both reminding of sounds provoked by plastic surfaces, they are pulse-like sonorities, never sustained, although sometimes appearing in swift repetitions. Since their appearance in measure 4 and 5, they seem to take the place of "click" and "thud": all of them are pulse like-sounds, but "tic" and "snap" are louder and in the foreground, whereas the other two are softer and more distant.

The last sound, "glass tone," is special in that it is the sound with the most pitch-like quality (or the least inharmonic spectral content). It is a fairly high sound, found at a frequency around 3000 Hz—around the piano seventh octave—so that it comes across quite clearly compared to other sounds. It serves as a sort of high pedal, counterbalancing the activity of the low pedal "fridge."

As we observe the behavior of the different sonorities as they appear in the first two subsections of Section I, several distinctive gestures particularly come across:

- The tension between stability and instability, both in timbre and "pitch"
- The glissando (sweeping) "motive"
- The accumulating density

The first aspect is the most prominent connotation of the entire piece. Tension is of course a standard musical feature. Here there is obviously no consonance and dissonance in a traditional sense, yet tension is put into effect via the "juxtaposition" of stable (sustained) sounds and unstable ones (short) and through the melodic 'disturbance' of sustained sounds. The appearance of new sounds also contributes in breaking the regularity of the musical flow.

The former element, juxtaposition of stable and unstable, exists by virtue of the different nature of the sounds present in the piece (for example, as we saw, in the introduction the piece manifests a contrast between the sustained "fridge" and the 'intrusions' of "click" and "thud"). Indeed, it is possible to group the sounds into three different categories according to their potential "stability":

a. Stable sounds (sustained): fridge, water tube, cricket, glass
b. Unstable sounds (pulse): mic thud, click, plastic snap, plastic tick
c. Hybrid sounds (can be sustained, but either their inner texture is fragmentary, or can appear as pulses): noise; wood crack, record crackle, mouth.

The element of melodic disturbance causes the sounds of the first category to become unstable at times. This element is of course manifested through the glissandos and changes in frequency. In the first two subsections we noticed such "disturbances" particularly in "water tube" (measures 3, 4, 5, and 6), "cricket" (measures 4-5), "noise" (measures 7-8), and of course in almost every statement of "fridge." As we mentioned for "fridge," glissandos function as punctuation marks and often incite the introduction of new material (i.e., "mouth" in measure 3, "cricket" in measure 4, "plastic tick" in measure 4, "wood crackle" in measure 5, "plastic snap" in measure 5).

The tension produced by the glissandos, by the progressive introduction of new sounds, and by the unpredictability of the pulse streams in the "unstable" sounds drives the piece forward with increasing intensity until a climax is reached (measure 9). Until the very last measures in this part, until the loud "tutti" climax in measure 9, the stable sonorities are impeded from being such, either by the presence of glissandos or fragmentation (brief appearances as opposed to long sustained stretches).

The only exception is "fridge," which as we mentioned provides the stability element for long-enough stretches so as to function as a term of confrontation against everything else. Because of this, the interruptions of "fridge," often initiated by glissandos followed by the introduction of new material (which often consists of a hit point in another sounds), are particularly relevant, and seem divide the subsections in small phrases formed by the paradigm *fridge stretch-glissando- new material.* The following outline pinpoints the phrases and their principal gestural elements in detail:

INTRO:

- Phrase 1 (m.1): pulse activity in "mic thud" and "click"
- Phrase 2 (m.2): pulse activity in "thus" and click"; "fridge" pedal; glissando in "fridge";

Subsection A:

- Phrase 1 (mm.3- mid 4): pulse activity in "thud" "click" and "noise"; double "fridge" pedal; glissandos in "fridge," and "water tube"; fragmentation of sustained sounds "cricket" and "water tube"; "mouth" hit at the beginning of phrase; sustained sounds "water tube," and "cricket" juxtaposed to "fridge"; "water tube" closes the phrase.
- Phrase 2 (mid m.4 – mid m.5): pulse activity in "thud" and "noise" (hits); double "fridge" pedal; glissandos in "water tube" and frequency changes "cricket" (with contour similar to other glissandos); fragmentation of sustained sound "cricket"; "mouth" and "plastic tick" hit at the beginning of phrase; sustained sounds "water tube," and "cricket" juxtaposed to "fridge"; "water tube" closes the phrase.

- Phrase 3 (mid m.5 – mid m.6): pulse activity in "thud," "noise" (hits) and "plastic snap" (hits); double "fridge" pedal; glissandos in "fridge," and "water tube"; fragmentation of sustained sounds "cricket" and "water tube"; "water tube" and "plastic snap" hit at the beginning of phrase; sustained sounds "water tube," and "cricket" juxtaposed to "fridge"; "water tube" closes the phrase.
- Phrase 4 (mid m. 6 – mid m. 7): pulse activity in "plastic tick" (hits); double "fridge" pedal; glissandos in "fridge," fragmentation of sustained sounds "cricket" and "water tube"; "water tube" and "plastic snap" hit at the beginning of phrase; sustained sounds "water tube" and "cricket" juxtaposed to "fridge"; "water tube" closes the phrase.

After the fourth phrase, we have a normal beginning of a fifth phrase around two minutes and ten seconds into the piece (mid of measure 7). The phrase begins with a "mouth" hit that reintroduces the double layer of "fridge." The new sound presented here is "glass tone," the most pitch-like and stable in texture of all the sounds of the piece. Between measures 7 and 8, however, we have the first hint of the "abnormality" of this phrase. "Noise," which had so far been unstable, starts displaying a tendency to stabilize, to become sustained. Instead of presenting a fragmented, pulse-like texture, it entertains here a sustained profile, although "destabilized" by fast glissandos. We notice that in this moment "noise" assumes a "metallic" color, emphasizing even more the importance of this change. Slightly afterwards, beginning of measure 8, "plastic tic" also starts striving towards stability (even though, as part of category b, true stability it can not achieve) by becoming more frequent and regular. Towards the middle of the measure, even "mouth" becomes less fragmented, and continues for about 10 seconds. At this point another novelty is added: we have 5 sounds playing at the same time, which had never happened before. This element provides an increase in density and loudness that quickly brings us towards the climax.

This arrives a bit before measure 9 (2 minutes and 40 seconds). Here “water tube” enters forte, and so do “cricket” (which also stabilizes in a longer stretch), and “noise.” The latter has at this point become a sustained sound, and displays a particular timbre: it reminds us of frying oil, thus exhibiting a clicky texture close to that of “record crackle.” This is a very important moment as it is the first example of hybridization of the piece, where one timbre seems to suffer from the influence of another. As we will see this will be a prominent feature of the second section.

At the same time “plastic tic,” “soft click,” and “glass tone” are also present in a more consistent manner. A hit of “plastic snap” at the beginning of measure 9 underlines the most intense moment of this section, which features 8 loud sonorities present at the same time (a sort of “tutti”).[12] Interestingly enough, during the climax “fridge” gets almost absorbed by the fierceness of the other sonorities, so that it seems to slowly disappear: at first its second layer (higher tone) at the beginning of measure 9, and then completely around 2 minutes and 50 seconds. Nevertheless, this has been the longest stretch for “fridge” so far (almost 40 seconds).

In the middle of bar 9 the climax starts to slowly wear off: “water tube,” “plastic tick” are interrupted, whereas “cricket” becomes fragmentary once again. “Fridge” and “mouth” are picked up in their stead, but “fridge” comes in softer then before. “Glass” becomes more stable, but glass is a delicate tone, making “mouth” very prominent in this second part of the measure. A

[12] It seems proper here to mention the concept o “holophony” as developed by Greek composer Panayiotis Kokoras. In P. Kokoras. “Towards a Holophonic Musical Texture,” (in *Journal of Music and Meaning* (*JMM*) 4, Winter 2007, section 5. University of Southern Denmark. Denmark), the composer describes how in his view 20th-century music has shifted from the homophonic-polyphonic texture of the previous century towards a “holophonic” texture (from the Greek *holos*= whole), in which, especially in electronic music, sonorities that are at first perceived as different elements are in the course of the composition fused together to create a single ‘sound cloud,” perceivable as a single element. This idea of course follows from the psychoacoustic concept of “fusion” mentioned above. The composer believes this treatment of music from a timbral point of view to be an important aesthetic principle shared by much music of the last decades.

hint of “noise” and subsequently of “plastic tick” at the end of the measure calls the climactic part to an end. At the beginning of measure 10 “mouth” is interrupted, and water tube is picked up instead, but softer than before. At this point, only the sustained sounds (category a) are present but all tending to soft dynamics, slowly fading out. By the time we reach 3 minutes and 20 seconds (measure 11) “water tube” has faded to silence, and “cricket” remains practically inaudible. Between 3:25 and 3:32 (mid of measure 11) everything comes to a stop, with the exception of a very faint presence of “glass.” This last passage, the fade to silence, brings subsection A to a closure, and prepares the arrival of B.

2.4 Reading the Transcription. The second subsection of *Audible Ecosystems 3b.*

The B subsection presents several differences from the previous: the most evident of these are the introduction of new sounds, and the complete absence of “fridge,” whose place is here completely taken by other pedal sonorities, particularly the higher “glass.” Indeed, the beginning of the section is supported by the stronger reintroduction of “glass” (serving here as a *trait-d'union* between the two subsections), along with an instance of mouth, which as we've seen often marks the beginning of new phrases. Unlike the previous subsection, B is not clearly divided in many phrases punctuated by the interruptions of the pedal. Here, we find primarily one stretch: we can hardly subdivide the passage in distinct units. On the contrary, there seems to be a continuity paralleling the typical ‘crescendo’ attitude of the piece. A divide could be perhaps identified with the swift volume increase at the end of measure 12, whereas the passage that precedes it gives the impression of a soft preamble, characterized by punctual interventions of different sounds against the pedal “glass.”

This preamble runs for almost thirty seconds without unexpected events; we shall note however, a momentary change of tone in “glass” at around 3:50, at which point the tone played by “glass” drops by roughly a major third. The initial tone is quickly restated a few seconds later. This momentary note change, producing a consonant interval, is a remarkable —albeit brief— moment, as it almost creates a melodic instance, in strong contrast with the inharmonic nature of this piece.

Other sonorities present in this part are “plastic tic,” “snap,” “record crackle,” “wood crack,”—the last two of which had not been present since the introduction—and “water tube.” All of these behave quite normally, with the exception of “water tube,” which appears in a sort of tremolo, standing out quite clearly at 3:44.[13] One may note that the continuity of “glass” seems to be interrupted at times by the interventions of other sounds, most notably “tic” and “snaps.”— Once again, as we notice previously, the stability of a sustained sound is challenged by fragmentations caused by juxtaposition—However, these interruptions are too short to give the impression of a phrase break. Only at the end of measure 12, as said, we face a significant change.

At this point, around 3 min and 55 sec into the piece, “record crackle” comes in more prominently (forte) and stabilizes, becoming sustained. This causes the overall loudness of the passage to increase significantly, and pushes “glass” from the foreground to the back. Such contrast is quite unique to this section: the faint, almost pitched pedal “glass” is now being confronted (for a long stretch of over 30 seconds) by the loud, noisy pedal created by “record crackle.”

The introduction of “record crackle” not only immediately increases the intensity of the

[13] This tremolo could almost be interpreted as a new sonority, in that the “tremolo” nature renders its association to “water tube” far from obvious. However, the sound is perceived as regular scratching of a hollow surface (wooden or metallic), and therefore can be indicated as a variation of “water tube.”

music, but also the density. Similarly to the “tutti” passage in the previous subsection, at this point it becomes more challenging to distinguish the nuances of every sonority, and “crackle,” the strong one, becomes the driving one. In this context, the perceived sonic effect can once again be that of holophony as described by P.Kokoras, in the sense that most sounds seem to intertwine to create a single sonic cloud, difficult to break apart perceptually. I write “most” in that such effect pertains to those sounds that manifest similar morphological characteristics: sounds that are “noisy” in nature, such as “snap,” “tic,” “noise,” etc., and are therefore prone to fuse together. Out of the sonic cloud, however, we can also find here sounds that are less easily confused and emerge quite clearly to the surface.

The first example is “whip delay,” in fact a new fragmentary sonority, which, as described above, recalls the sound of a whiplash. Coming in forte towards the beginning of measure 13 –shortly after the beginning of “crackle”– “whip” is heard very clearly, and acts as a kind of exclamation point to underline the change in texture that just occurred. “Whip” also restates the glissando gesture that was so present in the first subsections. As before, the glissando anticipates the occurrence of textural changes. Indeed, shortly afterward, one can detect the presence of “water tube” in the background (piano), now being re-stabilized after the previous tremolos. Additionally, at around 4 minutes and 13 seconds (second part of measure 13), a new stable sonority is introduced: “water pour,” a stable sonority which, for the similar timbre, comes in support of the fainter “water tube.” The presence of these two stable sounds at this point seems particularly relevant in view of the fact that at the same time glass is destabilized, as before, by instances of “plastic snap.” More specifically, every time we hear a “snap” instance, we notice a momentary interruption in “glass.” This confirms the already observed attitude of pulse sounds to interfere with stable sounds.

At the beginning of measure 14, the "water" sounds are interrupted to leave room to a new sonority: "slow record." Like "whip," "slow record" is heard quite clearly against the background. It also has a glissando quality (sweeping up and down in frequency). "Slow record" could be defined as a potentially stable sonority, although it does not appear for very long stretches (only a few seconds at a time) and is constantly destabilized by glissandos. Right after the second instance of "slow record," an important textural change takes place: the pedal "record crackle" is interrupted and substituted for by a new statement of "water tube" alongside "cricket." At this point the latter two are both forte, therefore making the change from "crackle" quite smooth. They are also supported by instances of "noise," although softer in intensity and quite in the background. At the same time, "glass" falls a bit in the background: it becomes fainter as its interferences tend to be more prominent. More specifically, we notice a few particularly strong instances of "snap" at 4:28 and at 4:37.

Right after the entrance of "water tube" and "cricket," another new sound is introduced: "mouse." This, obviously recalling the squeaks of the little rodent, is a stable sound, heard quite clearly due to its high frequency, and, like "slow record," sweeping through between different frequencies.

The entrance of this new sound, along with exchange between "crackle" and the other pedals, creates a density increase that reaches the maximum around the middle of measure 14, at which point one can detect six to seven different sounds playing at once. As we know, the tendency of the piece is to lead to saturation followed by quieting down: indeed, the dense climactic passage in measure 14 will lead to a fortissimo hit point followed by a fast trailing off of all remaining sound. This behavior differs from the previous subsection, in which there is no real hit point, and the fading off of the instruments happens over a longer stretch of time.

As one can observe in the subsection's transcription, shown in example 2.4.1, the climax in measure 14 proceeds for about fifteen seconds, with a dialogue between the pedal sonorities—one of which, glass, interfered with by the instances of “plastic snap”—and the sounds “mouse” and “slow record” which alternate as soloists. In this climax, as in that of the preceding subsection, we notice how the sounds tend to be stable, rather than fragmentary as it happens at the beginning of the subsections. The hit point is reached at 4 minutes and 40 seconds, beginning of measure 15. This consists of a hit of a new sound, “digital explosion,” which comes in very loudly, and momentarily covers the other sonorities. In the above list, I have used a Fennellian string to help characterize the nature of this sound, which is not easily relatable to real life.[14]

“Explosion” can be considered as the *akme* of the entire section. As the first true hit point, it brings the section to a closure. It is the only thing we hear for two or three seconds, and it seems to sum up the entire first half of the piece, by bringing it to a point of maximum saturation, by filling up the frequency spectrum (as can be observed in the spectrogram), and thus demanding subsequent relaxation. Indeed, after “explosion,” the section only lasts until 4:48, and before it goes to complete silence, only a few sonic events are detectable.

Interestingly, right before and right after “explosion” we have the introductions of a new sound: “far steps.” An unstable sonority, this—safe for an almost inaudible appearance in the next section—is its only cameo in the piece, and acts as a sort of frame to “explosion,” emphasizing its peculiarity. Besides “steps,” in the tiny coda following “explosion” we can hear the remains of only one pedal, “water tube,” along with fragments of noise, and instances of “snap,” which closes the section. One should notice how “snap” also appears, before the closure, in slightly altered fashion, almost as if it were played in reverse. This provides an element of

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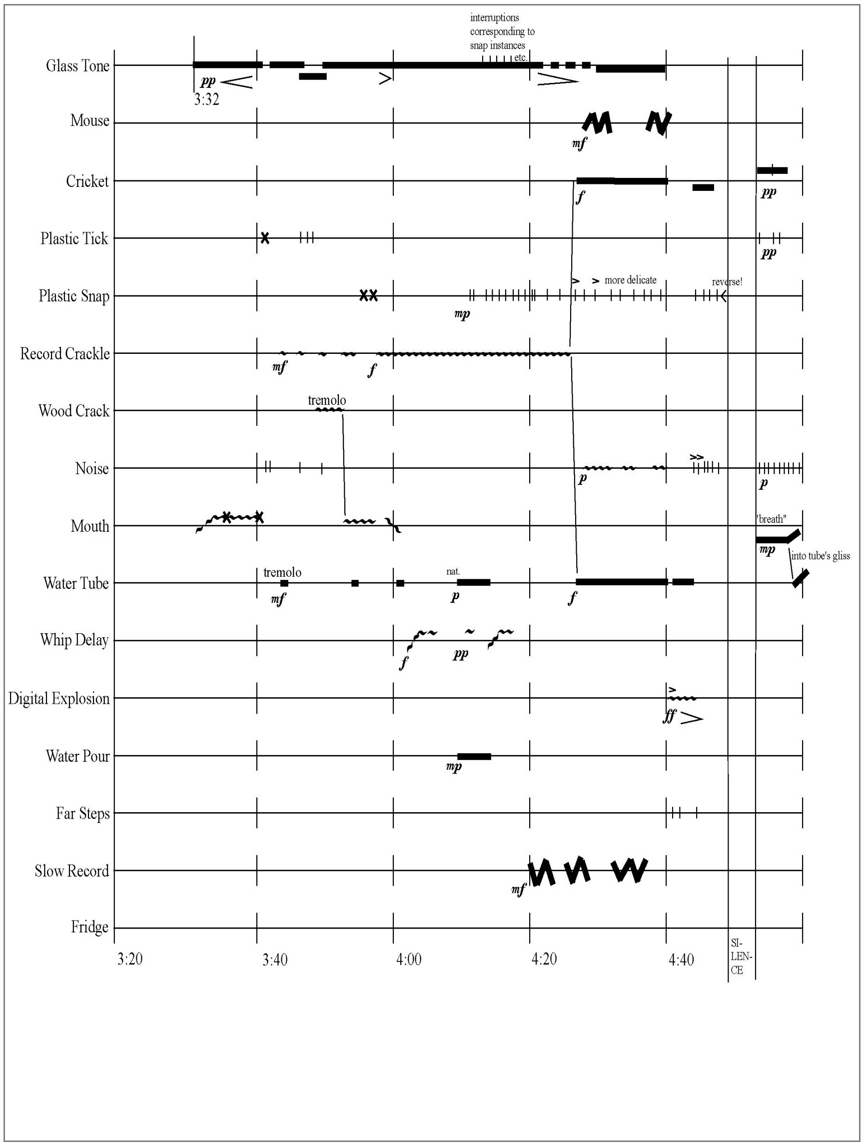
[14] If one would, it could be possible to make some sort of connection. I think, for instance, that a myriad of exploding bubbles could generate such a sound. To force such a connection, however, is beside the point, and has no analytical consequences.

variation, of destabilization of an already unstable sonority, which is akin to the chaotic nature to the piece.[15]



Example 2.4.1. The transcription of the third subsection (B) of Di Scipio's *Audible Ecosystems 3b.*

The end of this subsection, followed by four seconds of silence, brings the first main section of the piece to an end. Before proceeding to the next section, let us summarize subsection

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15 Indeed, as said, the very appearance of a sound is often marked by slight alterations. In this case it was particularly worth noticing, as the alteration is a bit beyond "slight."

B: the following outline presents the gestural features of the preceding passage:

- Prelude (mid m.11 – end m. 12): "mouth" hit at beginning of passage; "glass" pedal; fragmentation of "glass" through "plastic snap"; fragmentation of "water tube"; frequency changes in "glass"; pulse activity in "snap," "tic."
- Main phrase (end m.12 – mid m.15): pulse activity in "snap," and "steps"; "glass" and "record crackle" pedal; glissandos in "whip delay," "slow record," and "mouse"; fragmentation of sustained sound "glass"; fragmented sound "record crackle," and sustained sounds "water tube," "water pour," and "cricket" juxtaposed to "glass"; "digital explosion" hit at the end of passage.

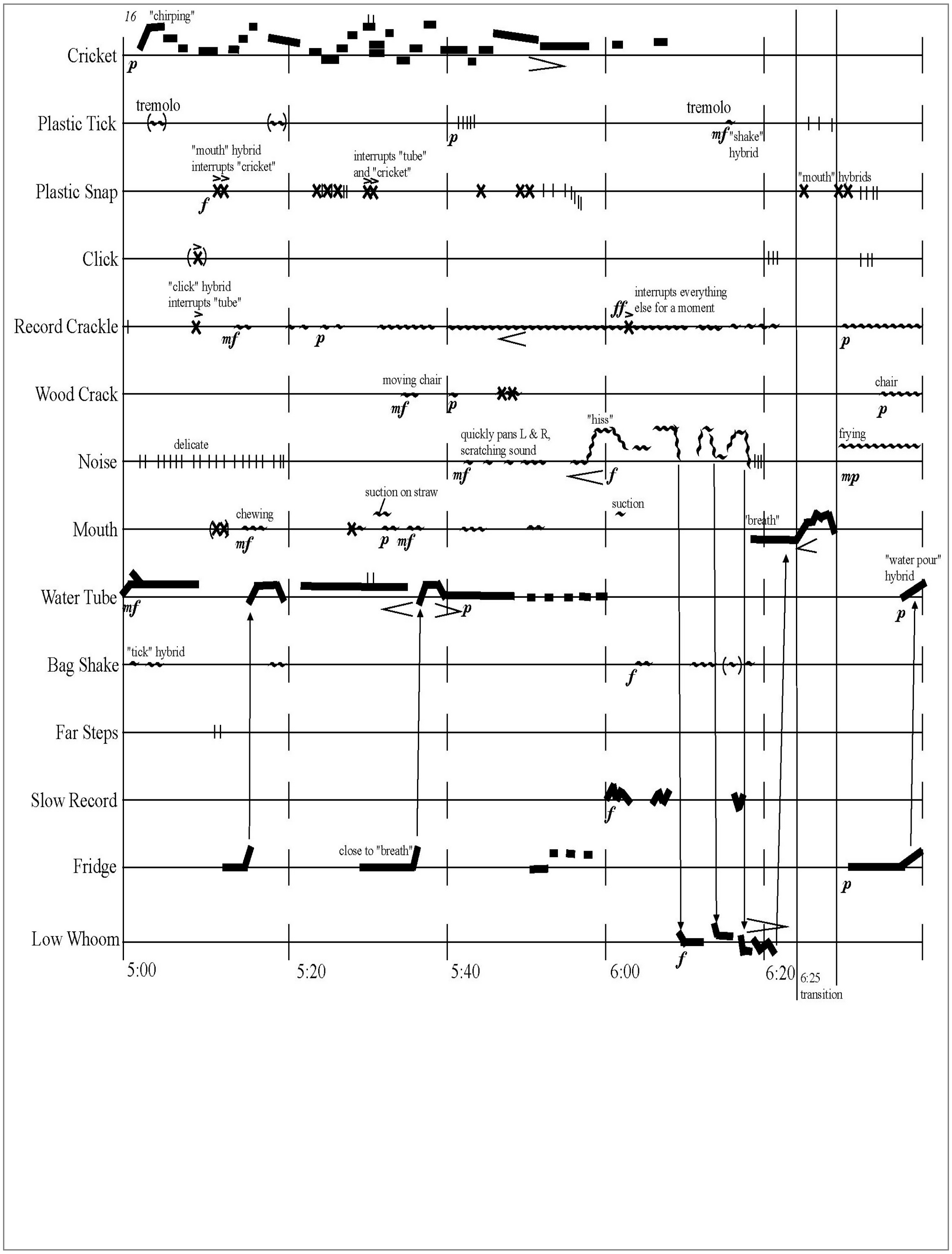
2.5 Reading the Transcription. The second part of *Audible Ecosystems 3b.*

The following subsections function as a sort of "development" restating and reworking the elements presented previously, and bringing the overall texture to greater density and intensity. Example 2.5.1 shows the score for second section. As one can observe, we have here a plethora of sonorities all displaying some degree of elaboration, either from a timbral or from a behavioral point of view, or both. The idea of "development" in a classical sense is given exactly by this sense of elaboration that is perceived throughout these sections. Typical characteristics of a classic musical "development" are: thematic elaboration, motivic interplay, motion to different tonal centers, and introduction of new material. In *Audible Ecosystems*, as a timbre-oriented electronic music piece, the above classic characteristics are transformed into: behavioral elaboration (sounds changing frequency more often), sonic interpolation (the interplay of different sounds already witnessed in the first part becomes more complex), motion to different timbre/sonorities (single sounds changing their spectral profile), and introduction of new sounds. Some of these phenomena have been present earlier in the piece in a less intense manner; the intensification occurring now, in the second part of the piece, makes the overall texture significantly more complex, and the task of transcribing rather slow.

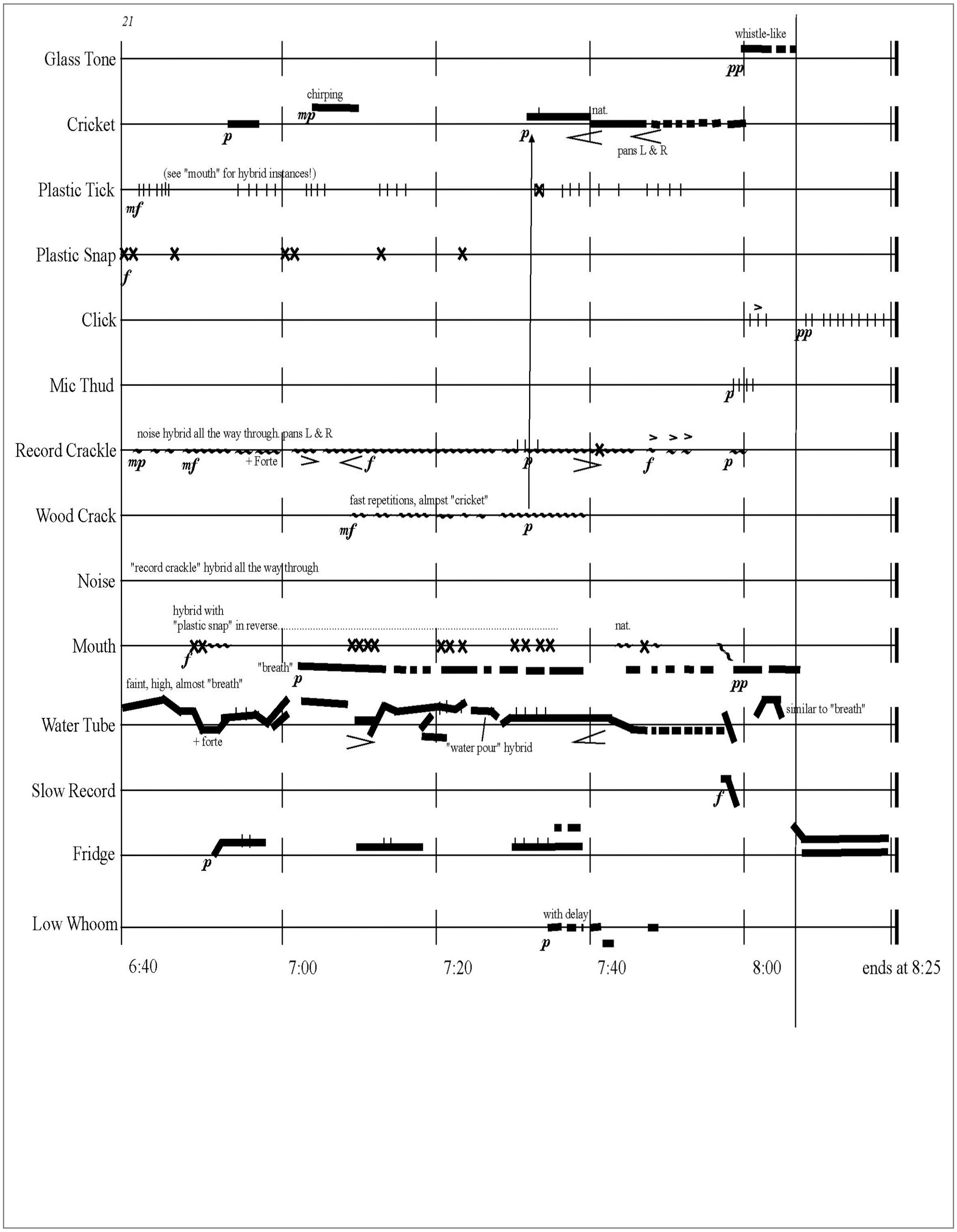
As we mentioned earlier C spans from the middle of measure 15 to the middle of measure 20. Subsection D (ending in measure 25) has a similar span, making the two sections well balanced in terms of length and texture. The process of density accumulation, described as typical of Di Scipio's piece, is repeated in the second section as well. Indeed, both C and D start softly, and then increase in intensity, eventually moving towards saturation.

Subsection C begins with a few sounds spanning from pianissimo to mezzo piano. Right from the beginning a new shade of “mouth” appears. This time the impression is that of a “breathing” noise. This, together, with a simultaneous entrance of “cricket,” creates a somewhat common pedal to which superimpose other elements. Indeed, soon enough the two pedal sonorities are juxtaposed to pulse-like instances of “noise” and “plastic-tick.” In a way, one might say that “breath” takes the place of “fridge”, being similarly low, sustained and stable sonority. Accordingly, at the end of measure 15 “breath” glides up as it was the case with “fridge” and leads us to measure 16.

From this point on, the true development begins. Just at a glance, the following four bars show a level of complexity that is unprecedented in the piece. At this point one cannot separate the passage into phrases, as we did for A. Even compared to B, the swift texture fragmentations, and the quick alternations between sounds prevent us from hearing definite structural brakes; it seems thus perceptually unfeasible to attempt to group the sounds in closed linear units. There is, however, a significant change as we reach the measure 19 climax, which is



Example 2.5.1. The transcription of section II of *Audible Ecosystems*.



Example 2.5.1. The transcription of section II of *Audible Ecosystems* (cont'd).

not really constituted by a "tutti," as it were before, but by a strong timbral modification, as we will see.

At the beginning of measure 16, the upward glissando of "breath" is taken on by "water tube," as it commonly happened with "fridge" in subsection A, before stabilizing into a sustained tone that lasts around ten seconds. At the same time "breath," left at a higher frequency, slowly wears off. During the first half of the measure we notice a number of elements acting as counterpoint to the pedal: first of all "cricket," which was left quiet at the end of measure 15, reenters with an upward glissando into a much higher frequency that transforms it into a sort of "chirping" sound; this "chirping" appears as being quite unstable, skipping down to lower frequencies and tending towards fragmentations (it comes and goes in small bits).[16] Secondly, we notice a number of interventions by 'clicky' sonorities, which in fact permeate the entire subsection. "Record crackle" is first, appearing here in pulses. It is then followed by a quite long run (spanning the entire measure) of delicate "noise" pulses, and by a mezzoforte instance of "bag shake": this is a new sonority that is somewhat reminiscent of a "plastic tick" tremolo, and in this instance it could be as well considered a sort of hybrid between the two sonorities. Such a hybridization of two sounds, part of a process of timbral elaboration and interplay, is very common in this section. Indeed, "water tube" comes to a halt with the arrival of a forte hit of "record crackle"/"soft click," which is very much in the foreground. The hit is shortly followed by another loud sonority, this time interrupting the chirping of "cricket." This sound, hybrid between "mouth" and "plastic snap," reminds us of the A subsection, which saw instances of "mouth" nearly always being followed by entrances of "fridge." In this case as well "fridge" starts right after (at 5:10), and its short statement concludes with an upward glissando that leads

[16] The initial behavior of "chirping," in terms of its 'melodic' contour, is similar to that of "water tube" in subsection A: a glissando upwards is followed by descent, reaching back to the initial frequency.

to water tube, again as in the A subsection. Interestingly, one can notice how the entrance of "mouth" is supported by two softer instances of "steps," which never comes back for the rest of the piece.

After the entrance of "fridge," "mouth" continues on with a kind of chewing sound, held forte against the low pedal. Also, "cricket" picks up the "chirping" where it was left, and restarts its fragmented drive, first moving upward in frequency, and then descending as the measure gets to an end. "Water tube," as mentioned, picks up from "fridge" and after a small upward glissando continues for a few seconds until the end of the measures, where it wears off in a downward glissando. During this passage one can also hear a short "plastic"/"shake" tremolo, and, more importantly, a short instance of "record crackle". This is more important as "crackle" tends to become more and more present in the section. Indeed, it opens the next bar (5:20) with three short but louder runs, which are very much emphasized, as the only thing that plays with them is a faint "cricket" chirping.

Measure 17 in general is similar to the previous, excepting a tendency for "water tube" and "crackle" to stabilize. Indeed, "water tube" will be present almost constantly throughout the bar, whereas "crackle" will begin a long stretch midway into the measure. "Cricket" continues its fragmented run in upward and downward frequency changes, obtaining the contour of a kind of interrupted wave. At times it assumes a polyphonic profile: e.g., around 5:30 we have three lines of "cricket" going on at the same time.

Throughout the first half of the measure, sparse hits in "plastic snap" continue to be heard very clearly, and for the brief time of their occurrence they interrupt at times, as it happened in previous subsections, their pedal counterparts. Similarly "crackle" keeps appearing fragmented in short bits, although at a much softer dynamic level.

As in the previous measure, around the middle of the measure a “mouth” hit sparks a new instance of “fridge,” which is now in a slightly higher frequency, making it closer to the “breath” we saw in “mouth.” During this stretch, which lasts until the end of the measure, “mouth” displays for a moment a peculiar timbre, reminiscent of a suction noise. As “fridge” begins, “crackle” also begins to stabilize, and although quite soft for the moment, comes as reinforcement to the pedals of this segment. At 5:15 “fridge” rises in its usual upward glissando, which, also as usual, is picked up by “water tube”, which becomes louder than before, before getting softer again as it slides down towards its initial frequency and stabilizes at the end of the measure. In this part, the most notable bit is the introduction of “wood crack,” one of the rarest sounds in the piece, which comes in mezzoforte right before “fridge’s” glissando, with a transformed timbre, now reminiscent of the squeaks of a chair being sit on.

At this point, at around 5:40, beginning of measure 18 in the transcription, with three soft pedal sonorities going on, the music is quite calm: it is only ‘disturbed’ by a short instance of “wood crack” at the beginning of the measure. After a few seconds, however, the texture becomes quite busy again. “Cricket” is again frequency fragmented, “tic” and “snap” start again to punctuate the music, ”crackle” becomes louder, “mouth” comes in again, “wood crack” reappears with a loud stretch, and most of all, noise is reintroduced much louder and with a new texture, which makes it reminiscent of scratching on a rough surface, almost becoming a new sound altogether; also, it pans quickly from the left to the right channel and backwards: all these characteristics give a very strong prominence to “noise” in this part, and indeed its transformations will shortly lead us to the subsection’s climax. Before then, however, we should notice how the second instance of “mouth” leads again into a statement of “fridge.” This time, though, fridge is too faint and fragmentary to become significant: it is almost crushed under the weight of “noise” and “crackle.” Also, around 5:55, we notice a peculiar instance of “plastic snap,” which, by getting suddenly lower in frequency modifies its timbre into an almost new sound, reminiscent of closing a larger box, rather than the cap of a pen. One should also notice how, after 5:50, “water tube” becomes fragmented, and “cricket” looses intensity and stabilizes, eliminating the frequency shifts. This fall into the background is again probably due to the coming forward of “noise” and “crackle.”

At around 5:55 “noise” starts again with a loud stretch. At the turn of the measure it slides up swiftly: an upward glissando that leaves on very high frequencies sounding, turning “noise” into a hissing sound. As this happens, “cricket” disappears. The high frequency “noise” is very hectic in nature: it is very loud and last only for a few seconds, and, more importantly, it quickly glides up and down in frequency, displaying a very unstable nature. The presence of the hissing “noise” is counterweighted on the one hand by the presence of a forte “crackle”, but supported on the other hand by the introduction of a fragmented “slow record,” which once again comes up in a climactic part, and behaves erratically by also sliding up and down in frequency quite quickly. Also acting as a counterweight is an instance of the chirping “cricket,” which comes at around 6:02, and on of “mouth”.   Soon after this, everything is abruptly interrupted by a fortissimo hit in “crackle.” Right after the hit everything stabilizes again for a moment: at this point “slow record” disappears in favor of “bag shake,” which is fairly loud.

Around the middle of he measure we get to the climax’ *akme*. “Shake” disappears and it is substituted for by “cricket” and “slow record,” which after about one second (6:11) immediately drop, whereas “noise” swiftly goes into a downward glissando, leading to a new sound, “whoom low:”[17] this is a stable sonority that is peculiar to the ‘development’. Quite

[17] The described event is prone to an alternative interpretation: after the downward glissando, the stabilization into this sort of ‘whoom’ could be seen not as an introduction of a new sound, but rather as a transformation of “noise” being quickly pulled into low frequencies, and then abruptly stopped, so that the only sound left is the more or less

loud, “whoom low,” as the name suggests, reminds us of a large amount of air passing through a container, and leaving much reverberation. Here it functions as an answer to the instability of “noise,” which generates a lot of energy by turning into “hiss:” such energy is released into “whoom low” almost as if the hissing “noise” were too unstable to continue for too long. Indeed, before the first “whoom” ends, another very high hissing begins, accompanied by “shake” and “crackle,” only to ‘fall’ again into “whoom” around a second later. This paradigm happens twice before the end of the measure. During this “hiss”-to-“whoom” moments we hear a number of brief instances of “crackle,” “tick” (in form of tremolo, again related to “shake”), regular “noise,” “shake” and “slow record” which comes in last before that last instance of “whoom” at 6:18. The only exception is provided by “mouth” (in its “breath” form), which provides a low pedal in the last seconds of the measure, in a way contrasting the frantic nature of this passage.

As the last presence of “whoom” trails off, it does so sliding up and down in frequency, thus becoming less stable. At the same time (beginning of measure 20, 6 minutes and 20 seconds into the piece), mouth (in the form of “breath”) becomes a bit more prominent, eventually taking “whoom’s” place, and functions as a calm end to the subsection, accompanied by a few interventions of “soft click.” A true fade to complete silence, however, never occurs, and the next subsection starts right away with the destabilization of “breath” through glissandos.

The climax of the C subsection is peculiar compared to the previous ones: the “hiss”-“whoom” paradigm creates a very intense effect, introducing new sounds and breaking the climax into several defying events, each of them signaling an apparent saturation point in the piece’s typical lead to saturation. For a number of times, it seems as the system is resisting the inevitable saturation, which eventually comes at measure 20. Also, the complete lack of stable

long reverberation that provides this kind of effect. I chose the idea of a new sound, as it seems to me too perceptually distant from the original (“noise”) to be indicated—unlike “hiss”—as a variation of it.

sounds, and all the intervention of the fragmented bits cause a strong sense of unpredictability and lack of reference points. Considering that all this occurs in the span of less than ten seconds, we can see how this climax consists not so much of a gradual increase in density, but of one of textural complexity: a saturation that is based on instability, rather then on the accumulation of stable and sustained sounds.

Before proceeding to the next part, let us summarize in the next outline the main gestural features of subsection C:

- New timbres in: "mouth" ("breath", "chewing," "suction"), "noise" ("hiss," "scratching"), "cricket" ("chirping"), "wood crack" ("moving chair"). New sound: "low whoom."
- Hybridization of "snap" with "mouth," of "shake" with "tick," and of "noise" with "mouth."
- Fragmentation of every sustained sound present, often through intervention of pulse sonorities.
- "Mouth" hits preceding "fridge" in measure 16, 17, and 18.
- Glissandos in "water tube," "fridge," "cricket," "slow record," and frequency changes in "cricket" and "plastic snap."
- Pulses in "snap," "noise," "tick," "soft click," "record crack," "steps." Tremolo in "tick," and panning in "noise," and "shake."

2.6 Reading the Transcription. The last subsection of *Audible Ecosystems 3b.*

As I have mentioned, the beginning of subsection D, the second part of the 'development,' is unusual as there is no real break from the previous part. We can identify a break in the 'development' (so to divide it in two subsections) in that after a clear climactic passage we enter a moment of soft regeneration. Normally this would arrive after a longer stretch of silence or near silence, but nonetheless, given the fall in dynamic and density, it seems reasonable to hear measure 20 as the beginning of a new section. The idea is also confirmed by looking at the spectrogram in example 2.3.1, which clearly shows a loudness diminution at around 6 minutes and 20 seconds.

C ends at 6:25 with a soft "breath" being destabilized in frequency through glissandos. At the same we hear a series of louder interventions by "tick" and a few hits in "snap" (here very close to "mouth"). In a way this passage function as a sort of transition from the previous passage, whereas the true beginning of D arrives around the middle of the measure, with the classic "mouth" hits (here again very close to "snap"), which precede an instance of "fridge" (here very similar to "breath"). Coinciding with the "mouth" hits, we have the beginning of a soft pedal, which is in fact that same variation of "noise," similar to the sound of frying oil, which we found at the end of subsection A. A little more prominent here that it was before, this seems to be a hybrid between "noise" and "record crackle." This, which is in fact the last appearance of this timbre in the piece, will last only until the end of the measure. Its presence, anyway, along that of "fridge," and of a "record crackle" pedal (here in a hybrid form close to "noise") starting simultaneously with it, will turn the second half of measure 20 into a rather stable passage, in a way sounding as a preamble (not unlike that of subsection B) to what will come. Naturally, elements of disturbance are not missing: along with pedals we have at first a number of instances of "tick" and "snap," and then a few instances of "wood crack" (in its "moving chair" form). Around 6:38, end of measure 20 in the score, "fridge" makes the typical upward glissando, which is picked up by “water tube”, at first seemingly being ‘hybridized’ with “water pour.” This launches D into its main part.

From measure 21 on, the texture of the subsection becomes really elaborate, and shows a high level of instability. The only sound that plays almost constantly, so to appear as the driving force of the passage, is “record crackle.” Its performance in a way shapes the subsection from a formal point of view. We should note that, as it is for C, it is hard to divide D in clear phrases, as its overall complexity and density make it sound as a single long passage. However, “record crackle’s” sudden diminution in loudness and activity in measure 23 seem to indicate a division point that splits the subsection in two parts, the first stretching from measures 21 to 23, and the second from 23 to 25.

Measure 21 begins with a “wood crack” instance that leads directly into a couple of “plastic snap” hits. In turn, they lead to a number of “tick” instances, which are then again followed by a “snap” hit. As all this occurs, we hear only two other sounds: first “water tube,” which here appears to be faint, very high in frequency, close to the breathing sound of “mouth,” and most of all, with a tendency to slide in frequency; second “record crackle,” which follows the “plastic hits” with three short instances, and also presents a quite new timbral layout, i.e., it now appears as a hybrid between “crackle” and “noise,” and has a tendency to quickly pan from left o right and vice-versa. Again, as a manner typical of this development, we notice how sounds can change their profile by mixing with others so to form a hybrid.

At 6 minutes and 47 seconds into the piece, “record crackle” becomes louder and sustained. Just a couple of seconds later, mid of bar 21, we have a series of hits followed by a fragmented stretch that appears as a hybrid between “tick” and “mouth”: it seems to be closer to “mouth” but it can also be interpreted as a kind of “tick” heard in reverse. This “mouth/tick” instance, played forte, ignites a piano instance of "fridge," which slides up in frequency as typical of its post-"mouth" behavior. Along with the normal instance, it is possible to hear a lower and softer voice in "fridge," creating a double, albeit fragmented and momentary, not unlike that found in subsection A. At the same time, "water tube," which had significantly decreased in frequency, is played louder and starts rising again, in a way following "fridge's" main path. The measure proceeds with the described texture, adding just a piano intervention by "cricket," and a few instances of "tick," which often, as usual, interfere with the regular course of the pedal sonorities. At the end of the measure, "fridge" disappears, while "water tube" rises and is doubled by a lower voice. However, "tube" is interrupted by two fortissimo hits at the beginning of measure 22, which momentarily take over everything else.

As soon as the hits pass, "crackle" and "water tube" start again where they left off, and another pedal takes the place of "fridge." This is a lower form of the 'breathing' "mouth," which while soft and fragmented it will continue until the end of he subsection.

After a few hits of "tick," (interfering with "mouth"/breath) a loud intervention of "cricket" begins, in the form of the high chirping described before. This momentarily seems to send "crackle" into the background: indeed, as "cricket" plays, "crackle becomes softer, even disappearing for a moment when "cricket" comes in. During the "cricket" instance, we hear a few mouth hits (again close to reversed "tick"). As the first hit occurs, it seems to ignite a few events: a frequency drop in "water tube," which also becomes softer; a new instance of "fridge"; but mostly a new mezzoforte stretch of "wood crack." The latter appears here in a form not unlike "cricket:" its texture is composed of fast pulses, almost giving the sense of a tremolo. It is, however, even more fragmentary, as it always appears in short stretches separated by pauses.

Soon after the "wood crack" beginning, "cricket" stops, allowing "crackle" to come back to the fore, again forte.   At the same time “water tube” rises again, going back to higher frequencies but still maintaining a sliding attitude. Also, after the “mouth” hits (resembling reverse “tick”), “tick” goes back to normal, having several interventions before the end of the measure. One of these is coupled with a “snap” hit, which causes interruptions in “fridge.”

Everything progresses in a similar manner until the end of the measure, at which point “fridge” stops, and “water tube” adds two new voices: a piano instance in the lower (and normal for this sound) frequency range, and a short upward glissando similar to that of the previous measure. This short slides appear as broken versions of the longer upward/downward motif of the A subsection, typical of pedal sonorities.

At 7 minutes and 20 seconds into the piece, beginning of measure 23, we have a new “mouth/reverse tick” series of hits, three to be exact. These are quite loud and to the fore as usual, but only seem to interfere with water tube. Around 7:25 a “snap” hit seem to ignite a change in “water tube,” which suddenly drops in frequency, becomes louder for a few seconds, and appears in a texture similar to that of “water pour,’ which we saw in subsection B. As this “water tube” instance ends—around the middle of the measure—we seem to reach a turning point in the subsection.

“Water pour” begins again softer and stabilized at a normal frequency. However, right after its start two particularly loud hits in “mouth/reverse tick” interrupt it and “record crackle” as well. At this point “fridge” comes back again doubling “water tube” (i.e., entertaining the same fragmented behavior). As “crackle” restarts, it begins to become fainter, and as “mouth” hits again, “water tube” and it stop again. This second pause constitutes the exact turning point, in a way the end of first main phrase of D, and it could be misunderstood as the end of the saturation point, i.e., the end of the section. Indeed, at this point the passage not only changes texture, but also it immediately drops in intensity. More specifically, the two greater forces of the first phrase “crackle” and “wood crack” come back piano, thus dropping the whole dynamic level of the passage from forte to piano. In addition, “wood crack,” already close to “cricket” as it were, is now even closer to it, to the extent that we may see the sound now as a version of “cricket” being influenced by “wood crack,” and not vice-versa. We are now at 7 minutes and 32 seconds into the piece, and at this point “fridge,” water tube,” and “breath” stabilize and join “cricket” and “record crack” in a five-pedals soft, stable passage that is unique in the whole ‘development’ section and preludes to the final rush of the piece.

As I have mentioned, however, the texture of the development remains quite complex throughout, so in this part as well, the calm moment is disturbed by three elements: first a loud “tick” hit which takes over for a moment and interrupts the pedals, and is followed a number of softer instances; second, the intrusion of two higher frequency short instances of “fridge,” which seem to contrast the behavior of the lower voice; third, and most important, the entrance of “whoom low,” which we saw playing an important role in subsection C. It comes here as a series of short instances, disrupting the calm of the pedals, with a timbre slightly different than before, namely with the addition of a delay effect.

At 7 minutes and 40 seconds things change quite radically: “fridge” and “breath” stop; “cricket” becomes much louder and goes back to its original self in terms of timbre (thus abandoning the idea of “wood crack” completely). At the very beginning of the measure it is also doubled by a higher frequency voice. “Water tube” also becomes louder and unstable. One may say that “cricket” takes here the role that was previously assigned to “record crackle,” becoming the most prominent sound of the last part of D. —Interestingly enough its prominence is not so much given by its loudness, but by its consistency. Indeed as the following events take place, “cricket” will keep sounding on its own terms, always audible, and interrupted only by random fragmentation—

“Record crackle,” on the other hand, after a small hit at the very beginning of the measure becomes even softer, disappearing completely around 7:46. As this happens we hear a “mouth” hit, this time in its regular timbre, soon followed by the entrance of “breath.” At the same time “water tube” slides down in frequency, preparing us for the final climax of the piece.

As we reach the middle of measure 24, two of the pedals currently playing, “water tube” and “breath” are interrupted by a “mouth” instance, a “tick” hit, and most of all by a concurrent “record crackle” forte hit. As soon as the hit is over the pedals start again. This pattern repeats a few times, giving the impression of a very unstable moment. At 7 minutes and 55 seconds into the piece, however, “slow record” comes in together with “mouth,” with a gesture that leads the section to a stop, suppressing most of the other sounds. After a forte start indeed, “record” and “mouth” immediately go into a downward glissando, ending in a very low frequency about one second later: a sign of saturation being reached, which provides a almost literal sense of closure (i.e., a sound reminiscent of a box being closed). Nonetheless, at this point we still have a small ‘codetta’ before the end of the subsection.

“Record crackle,” and “breath” come back right after the glissando, but now piano, and contrasted by pianissimo instances of “mic thud” (which comes back for the firs time since the beginning), and noise. “Cricket,” which had kept sounding over the course of the events, also continues its race. As the measure reaches the end, however “record crack” and “cricket” stop. “Cricket's” role as leading pedal is taken by “glass,” which comes back very softly, in a high register (reminiscent of a whistle). As we enter measure 25, all the sonorities present are playing pianissimo, and the texture is much less dense than before.

At first “breath” and “glass” are sustained, and their performance is now also punctuated by pianissimo “soft click” instances. As we get to 8 minutes and 5 seconds into the piece, “thud” has stopped, and they start becoming fragmented. At the same time we hear a faint instance of “water tube” that comes in with an upward glissando. This instance, which appears as being hybridized with “breath,” reminds us of the behavior of “water tube” in the first subsection, and most of all, of “fridge” at the beginning of D. As we have mentioned at the beginning, this kind of sound is most likely related to the opening of the performer’s mouth; in this instance it probably signals that he is removing the microphone out of his oral cavity. Indeed, after the slow upward glissando the sound becomes even softer and initiates a downward glissando before disappearing completely. As it does so, “breath” and “glass” also disappear, bringing the subsection to its actual halt.

Interestingly enough, the accumulation toward saturation typical of other subsections is less evident in D, if we consider, for instance, the explosion in B compared to the downward glissando of D. This seems to be due to the fact that the density and dynamic levels in D are steadily high, almost as if the section represented a giant saturation point for the whole piece. In a way, this can be true, as we will see in the latter analytical assessment.

As usual, before proceeding to the next part, let us summarize in the next outline the main gestural features of subsection D:

- New timbres in: “plastic tick” (“reverse” effect); also, all those found in C. Return of “frying oil” effect in “noise,” after the first subsection.
- Hybridization of “tick” with “mouth,” of “wood crack” with “cricket,” “water tube” with “breath,” and of “record crack” with “noise.”
- Fragmentation of every sustained sound present, often through intervention of pulse

sonorities.

- "Mouth" hits preceding "fridge" in measure 21, 22, and 23.
- Glissandos in "water tube," (particularly notable) "fridge," "cricket," "slow record," and frequency changes in "water tube."
- Pulses in "snap," "tick," "soft click," "mic thud," "record crack," "wood crack."
- Tremolo in "wood crack," and panning in "record crack," and "cricket."

The Coda begins at exactly 8 minutes and 9 seconds into the piece. In a sense, it mirrors the introduction, in that very little is going on (the microphone is not being used) and we only have one main pedal sonority present, punctuated by a pulse sonority. The main pedal, "fridge" comes in a manner that is similar to its behavior in section A: it is divided into two voices: one upper and one lower; the lower is steady as normal, while the upper comes in with a downward glissando. This follows directly from the ending "glissando" of water tube," creating a kind of opposite gesture to that we were used to hear (upper glissando in "fridge" being taken on by "water tube"). As the glissando ends the sound stabilizes into a sustained pedal, very soft in intensity. Until the end of the piece, however, it is always punctuated by pianissimo hits of "soft click," reinforcing, even in a simple way, the classic paradigm of 'tension' being put into effect through the juxtaposition of stable and unstable sonorities.

At 8 minutes and 25 seconds, the piece comes to an end through the interruption of the last sounds. Consisting only of activity in click", and in the "fridge" pedal with its glissando, it is not quite necessary to outline main gestural features of this subsection.

At this point we have traced in detail the surface evolution of the piece, following the behavior of each sound by aural perception, with the aid of the technology at hand. We have in fact described and shown in the transcription the development of a musical piece, almost as if it were a piece for percussion instruments. Having now a clear idea of what happens in the piece, we can finally apply different analytical techniques to unravel some of its structural properties. This will be the subject of the following paragraphs**.**

2.7 Analyzing *Audible Ecosystems 3b.* Density and Dominance.

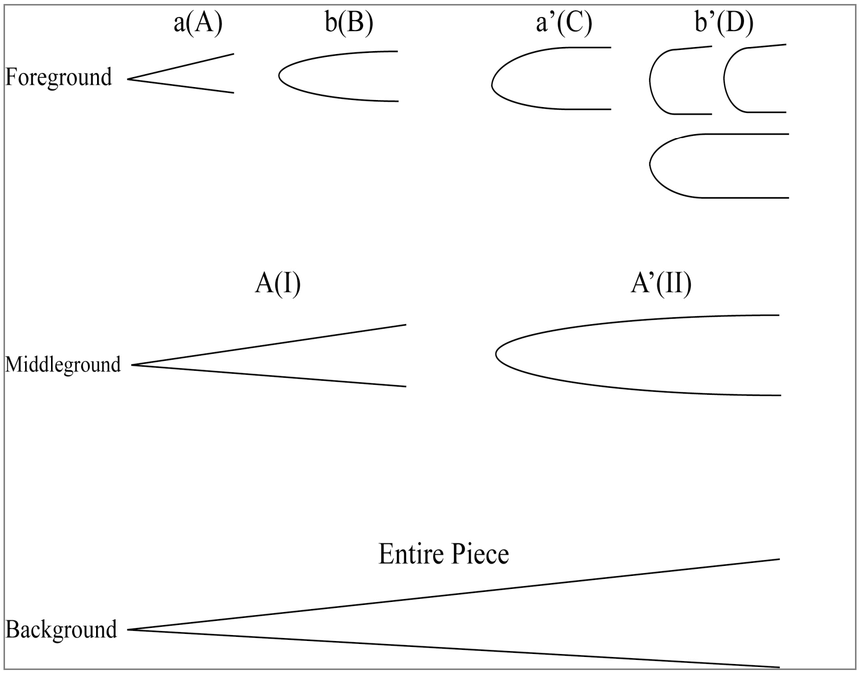
In terms of form, it is possible to make some modifications to our original outline, which was primarily "dictated" by a first hearing and visualized in the spectrogram. As I have noted, there exist similarities between what I called "development," and the first part of the piece. In particular, subsection C appears to share certain traits with A, such as the soft, low pedal beginning ("fridge" in A becomes "breath" in C), followed by glissandos picked up by "water tube," and the "mouth" hits followed by "fridge" stretches. In this sense, it can be possible to trace a parallel between these two subsections and rename C as A'. Similarly, one can trace a parallel between subsection B and D, if one considers the main phrase supported by the forte "record crackle," whose role is then transferred to "cricket" and "water tube" as we approach the climax and closure. Accordingly, in this view D can be seen as a sort of B'. These observations transform the formal scheme of the piece from the vague: A-B-C-D, into the common: a-b, a'-b'. This idea is also supported by the fact that the only strong division in the piece exist between b(B) and a' (C), around half way into the piece, where we have a few seconds of silence. If we fit our new form into a larger scheme, we can then interpret the piece as a large binary form A-A', where A' presents itself as a very much elaborated version of A, as we've seen. The following outline shows the form of the piece according such considerations:

Section A mm. 1-mid 15 | Section A' mm. mid 15–25

Intro - a - b a'-b'- Coda

Concluding that *Audible Ecosystems* is a binary form may seem a bit far-fetched at first, but one may see how it makes sense in view of the performance score created by Di Scipio. Indeed, the score shows that the performer has to go through the drawn measures twice, and that the second time around the performance occurs with significant variations. It is true that the piece is chaotic in nature, and that the correspondence between what the performer is doing and what we hear is often not so direct; on the other hand, some elements resulting from compositional decisions do emerge, the most structurally relevant of it being of course the binary form.

On another level, unrelated to the layout of the performance score, but related to the nature of the process employed, that of feedback and its natural tendency to grow in intensity, we can observe how the piece not only displays a timbre-related binary form (that is, derived from the organization of the different audible sounds), but also a directional design that is inferred from the density/loudness levels of each subsection. Indeed, I have mentioned several times how each subsection has a tendency to become denser and louder as it progresses, and how this is due to system process, which tends to saturation and to starting over after it has reached it. From the description I have made above concerning each subsection, however, one can infer how not only each sections grows louder and denser as it reaches its end, but also how each section appears to be generally louder and denser than the previous, and/or to become louder and denser more quickly. This means that the tendency to grow not only pertains to the subsection level, but also to the section level and, ultimately, to the entire piece. Example 2.7.1 presents the growth pattern from the foreground level (subsection), to the background level (entire piece). The brackets



Example 2.7.1. Density Graph for *Audible Ecosystems 3b.* In parenthesis the alternative names for the sections as used throughout the chapter.

underneath each section's name illustrate how the density increase, slow and gradual at the beginning, becomes faster as the piece proceeds. This allows us to assert not only that section A' works in a similar fashion than A, but also that it is generally denser and louder, thus explaining the background's single bracket, which shows a constant increase over the span the piece.
The graph interest lies in the fact that it points out a large-scale pattern that gives a strong sense of directionality to the piece: this kind of goal-oriented motion is difficult to visualize on the spectrogram alone, but it is made clearly visible by the transcription.

Returning to timbre, after having described the evolution of the piece in detail, we can now make several observations that are quite important in shaping our understanding of the structure of *Audible Ecosystems*. Indeed, from the above descriptions we can infer that each subsection contains sounds that are dominant over the others.[18] By 'dominant' I mean thos e sounds that have a greater impact in transmitting an overall perception of the passage, the overall "color" of the subsection. Their dominance is given primarily by two simple intuitive factors: how long and how loud they play (or more precisely: how loud we perceive them to be: how clearly they emerge to the fore).

Sounds that are both loud and that appear for long stretches of a section, naturally tend to make a stronger and longer-lasting impression to our ears. In *Audible Ecosystems* the dominant sounds tend to be always the same (with some exceptions of course). What changes is the level of their importance within each section. Observing this allows us to understand why some parts seem to have a peculiar character, whereas others, very different in the details, share a certain 'feel'. The following table presents the dominant sounds for each subsection. They appear, from top to bottom, in order of importance (top is more dominant). Some sounds, listed in the same ranking position, have approximately the same relevance. "Plastic tick" and "plastic snap," closely related as they are, are grouped under the term "plastics":

[18] Obviously the term 'dominant' is not used in its musical sense, but in its literal one. The idea of timbral dominance is related to the concept of timbral hierarchies as described by Lerdahl (1987). However, unlike Lerdahl I do not intend to be systematic or absolute, but rather contextual, simply suggesting that, due their stronger presence in the piece, some sound objects appear as more prominent, more easily remembered than others.

Rank \ Subsections	a(A)	b(B)	a'(C)	b'(D)
1	"fridge"	"record crackle"	"water tube" "cricket"	"record crackle"/ "noise"
2	"water tube" "mouth"	"glass"	"mouth"(breath)	"water tube"
3	"noise" "cricket"	"water tube" "cricket" "noise"	"noise"(hiss) "low whoom"	"wood crack" "cricket"
4	"plastics"	"digital explosion" "slow record"	"plastics" "record crackle" "fridge"	"mouth" (normal & breath) "plastics"
5			"slow record"	

Just by glancing at the table is possible to isolate a few rogues. In particular, we notice the one time presence of "digital explosion," of "low whoom," and "wood crack." Despite the fact that the first two appear only once over the course of the piece, they can be indicated as dominant in that they are extremely loud and occupy very important places at the peaks (saturation points) of their respective sections.--indeed they are very easy to detect and they come vigorously to the fore-- Excepting the rogues, however, the remaining sounds tend to be always the same. This of course means that there is a certain timbral consistency throughout the piece: the piece maintains the same general 'color' without shifting abruptly. We could say that the piece has a very strong timbral coherence, just as a motive-based piece may have thematic coherence.

Moreover, the dominant sounds also tend to occupy similar ranks across sections. This means that each subsection is dominated firstly by either low-frequency stable sonorities, or hybrid sonorities (those that have fragmented texture with strongly inharmonic, noise-like spectra), making the overall tone of each section quite dark, and secondly counterweighted by higher-frequency sounds. There is, however, a crucial exception. The most dominant sounds of section a'(C) are "water tube" and "cricket," which are stable sounds (with pitch-like qualities) of relatively high frequency, at least compared to fridge. This of course sets a 'contrary' tone for a', which appears with a brighter dominance counterweighted by darker colors, and inverts the general tendency of the piece. Since a' is a part of what I metaphorically named 'development,' its inversion of tendency could be considered as a form of variation from its corresponding section a. Indeed, they both rely heavily on stable sonorities, and in most cases same sounds occupy same ranks, but a' shifts the attention onto a higher side of the spectrum.

With regards to b(B) and b'(D), a nice variation—albeit less strong than the one just mentioned—can be noted in the substitution of "water tube" in b' for "glass" in b, as a second rank sound. Both stable sounds, they are differentiated by quite strong spectral differences, implicit in the names themselves, and by a frequency shift from middle register ("tube") to high register ("glass").

From the table it is also possible to infer cross-subsection dominance patterns. For instance, from subsection a to b there are only three sounds that appear consistently dominant (to a greater or lesser extent): "water tube", "cricket," and "noise." We can thus assert that these are the dominant sounds of section A. Among them, "water tube" occupies the highest ranks: indeed, "tube" is the most dominant sound of A. According to the same principle, in A' we have more dominant sounds: "water tube," "cricket," "noise," "mouth," "record crackle," and "plastics."

There are thus more dominant sounds in section A' than in A. Among them "water tube" occupies the highest rank, followed by "cricket" and "noise," then by "record crackle," then by "mouth," then by "plastics." The two sections, then, have similar dominance, although A' is colored by several unstable and hybrid sounds, reflecting its higher level of complexity, and its status of variation, of 'development' of A.

From the two sections' dominance patterns we can infer that "water tube" is in effect the most dominant sound of the piece, followed by "cricket" and "noise." Although we can not really assert that because of this the piece is eminently mid-frequency based and stable (since "water tube" is normally not in the first rank in the single subsections), we definitely conclude, due to its constant presence, that the piece seems to balance around it, and to use it as the primary tie to provide an overall sense of timbral coherence.

It may be possible for one to include another parameter into the dominance scheme, one that was hereby voluntarily omitted: that of temporal order. Indeed, one may argue that if we take two sounds, A and B, of equal (or very similar) duration and loudness, A will sound more dominant than B if heard first. However, it seems to me that over the course of a section, especially a long one, precedence will not be as relevant as the other parameters already taken into account.

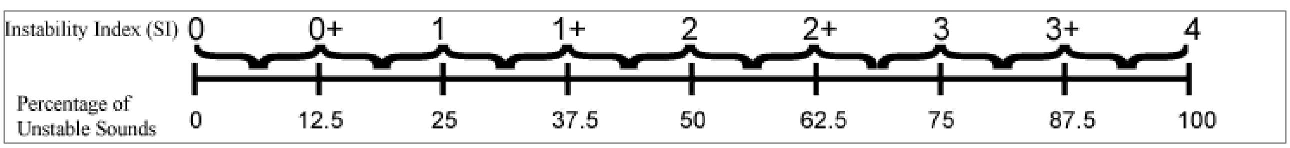
2.8 Analyzing *Audible Ecosystems 3b.* The Instability Index.

We should now discuss another important feature of *Audible Ecosystems 3b*: the tension-release paradigm, realized here through the alternation between timbral stability and instability. This has been examined on the surface level throughout the score reading above as a constantly present element, so that I went as far as labeling it: “the most prominent feature of the entire piece.” Indeed, this seems to be the piece's driving force just as the alternation between consonance and dissonance in a tonal piece. Such paradigm is different from the previously discussed elements of density and dominance. The latter are in fact quantitative elements, in the sense that they are dependent from the quantity and loudness of the present sounds, and the duration and loudness of the present sounds respectively. On the other hand, stability vs instability is a qualitative element, dependent on what kind of sounds are present at any given moment of the piece, and on what behavior they entertain. As we have seen quite in detail, in Di Scipio's piece tension is achieved by destabilizing otherwise stable sounds (i.e., sustained and stable in frequency) either through the intervention of unstable sounds, or through variations in frequency (such as the observed glissandos) or continuity of the stable sounds themselves.

In a tonal piece, once we realize where and which are the dissonances, and where and which are the consonances, we can call the chords as vessels of tension or release, and we can make a series of observations that shed light on how the piece is organized by way of examining the transformations between one element and the next, and examining if such transformations are present on a higher level as well. In a similar way, in a timbre based piece such as this, after having described in detail where and which are the stable and the unstable sonorities, and after having laid them out on a score, we can observe what is the stability level at any given moment, and we can thus examine how the stability changes both at a local level, and at a higher level.

Indeed for any given “moment” of the piece, which could be of any temporal length (e.g., a split second or an entire section), we can determine how unstable it is by calculating how many unstable sounds (including stable sounds that are being evidently destabilized) are present and how many stable sonorities are present. For every passage we will have a certain percentage of stable sounds and a certain percentage of unstable sounds. Accordingly, we could say that a certain passage is eminently stable (thus a release moment) if the majority of sounds are stable, and unstable (thus a tension moment) if majority of sounds are unstable. For simplicity sake, I will divide the percentage scale in a few sections, each of which will be represented by a number. I will call such number the "instability index" of a given passage, or SI in short.

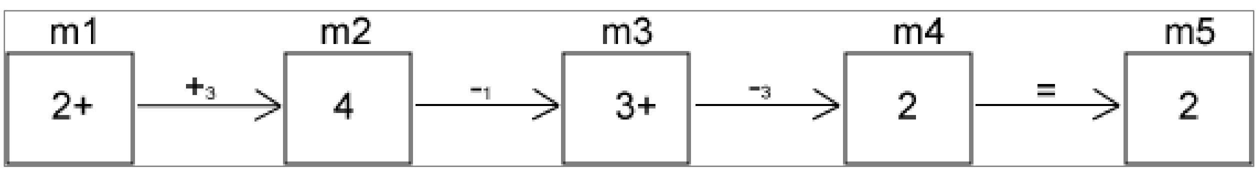
Example 2.8.1 shows a comparison graph relating the percentage scale to the SI. The INSI runs from 0 to 4, with 0 identifying a passage without unstable sounds, and 4 one without stable sounds. Thus, 0 corresponds to 0 percent of unstable sounds, and 4 to 100 percent of unstable sounds present. In between these, 1 corresponds to 25 percent., 2 to 50 percent, and 3 to 75 percent. Using these five values alone could prompt to too large approximations, so values in between can be used such as, 1+ (37.5 percent approx.), 2+ (62.5 percent approx.), and 3+ (87.5 percent approx.).



Example 2.8.1. Relation of SI to percentage of unstable sounds in a given passage. SI numbers are associated to an approximate percentage (see approximation bracket).

As said, the SI can be determined at any level of the piece. To examine the local level for *Audible Ecosystems 3b* I suggest a minimum stretch of 5 seconds, to allow perceiving a sustained sound clearly as such. What this means is that, in order to be able to count a sound as stable, the sound must run for at least five seconds in the same frequency or in the same narrow frequency range. So, not only unstable sounds will be counted as such towards the SI, but also stable sounds whose sustained runs are either shorter the five seconds, or fluctuating in frequency, or both. For Di Scipio's piece, this general rules allowed me to count four different SI's for each measure. For the time being, I will use for analytical purposes SI's pertaining to entire measures, and SI's pertaining to entire sections.

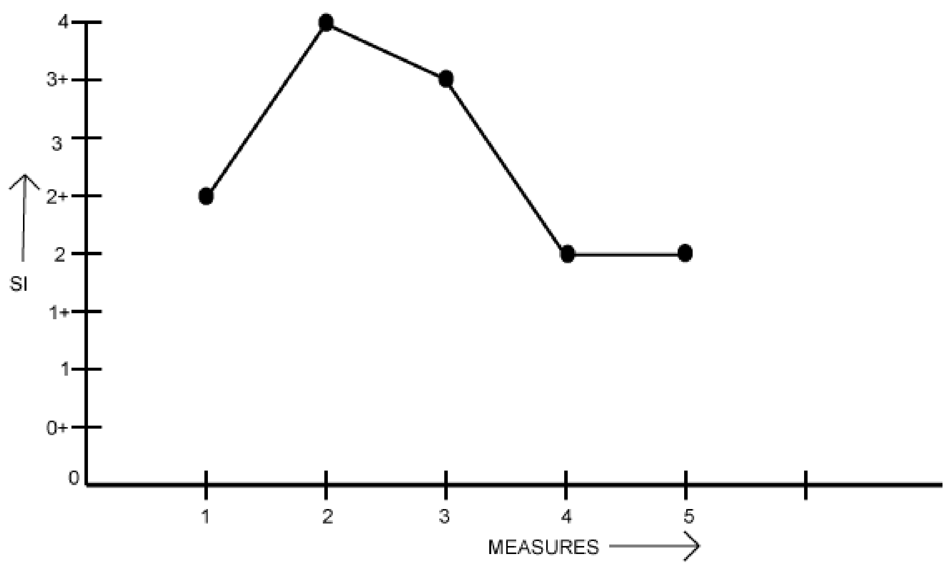
Transformations between different SI's, that is the motion between one passage and the other observed through their SI's, can be accounted for through three different operators: +, indicating an SI increase, – indicating an SI decrease, and = indicating the lack of change of SI between passages. The symbols + and – will bear a subscript indicating the amount of change between one SI and the next. In other words if the first SI is 0 and next is 0+, the operator involved will be $+_1$. The maximum gap between two SI's will be 8, separating 0 from 4 and vieversa (thus $+_8$ or $-_8$). For example we could visualize a network displaying the motion from measure 1 to measure 5 of an imaginary piece in the following way, shown in example 2.8.2.



Eample 2.8.2. Example of a possible network showing a SI transformation pattern.

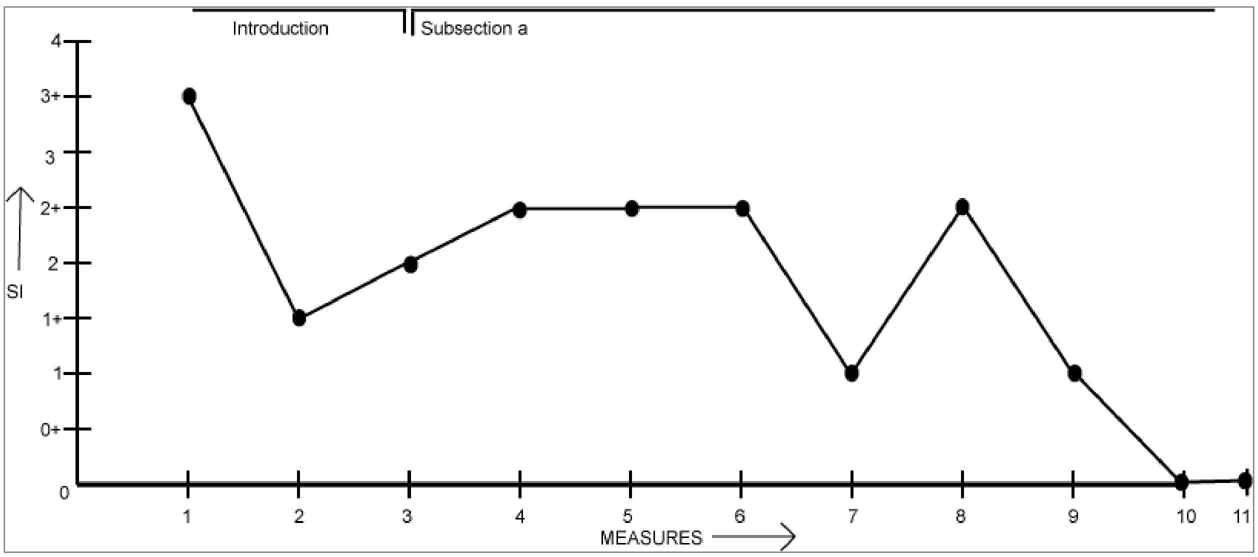
In the example, the operators show the transformations occurring between the SI's of each measure. Networks such as this could be easily compared to that of other passages of the same piece, and even to hyper-networks from the same piece as we will see. It is important to note that, since the nodes of an SI graph contain a measure of a certain quality of a passage, rather than that of specific objects, two identical graphs can be a positive fact, because they can show how very different musical passages behave in the same way (as two different musical passages could be characterized by identical chord progressions).

Another possibility is to visualize such transformations on a Cartesian graph. For example, taking the imaginary passage before, and setting the SI scale on the Y-axis, and time, i.e. measure numbers, on the X-axis, we would get a series of point on the graph, which can be connected through lines. Lines moving up from left to right would represent the + operator, lines moving down from left to right would represent the – operator, and horizontal lines would represent the = operator. The linear output of the passage would be peculiar to that particular passage and could be easily compared to the linear contours of other passages. Example 3.8.3 shows the Cartesian graph for the passage above.



Example 2.8.3. Example of Cartesian SI graph.

Accordingly, we can analyze Di Scipio's piece in the same way. Example 2.8.4 shows the SI graph for *Audible Ecosystems 3b's* Introduction and subsection a. From the graph, we notice how after an initial descent from the first measure, the piece increases its tension level to around SI 2/2+ until we reach the climax of the first section, with one exception, a drop to an SI 1 in measure 7. As we have mentioned, in the second part of the subsection the piece moves towards stability so that we notice an SI of 1 at the climax measure (m.9), moving down to 0 (no instability whatsoever), as the subsection moves to an end.[19] If we average all the SI's of the sections we will get two SI's, one for the Introduction and one for section a. Indeed the introduction has a general 2+ SI, whereas subsection a has a 1+ SI. We finally notice a great amount of 2+ in the first part of subsection a, thus showing a significant continuity in terms of overall SI oscillation, in line with the somewhat repetitive nature of the first phrases of the subsection.

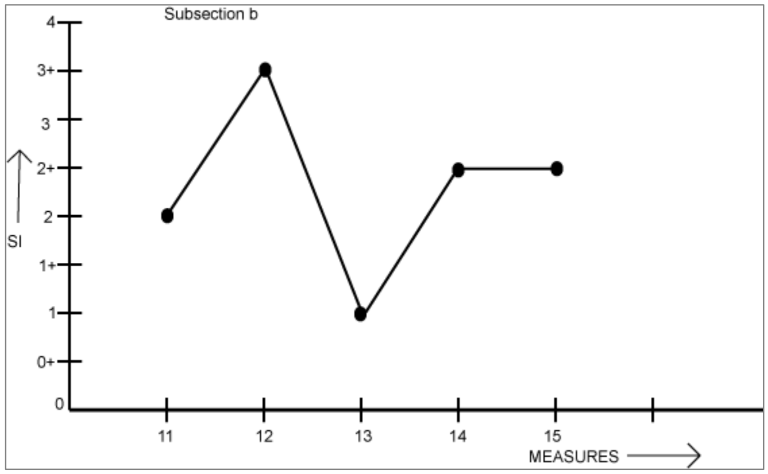


Example 2.8.4. SI Cartesian graph of the Introduction and Subsection a of *Audible Ecosystems 3b*.

Example 2.8.5 shows the SI graph for subsection b. This starts with a middle SI of 2, which rises to 3+ in measure 12, indeed a very unstable measure. After measure 12 the SI drops back to 1, before rising again in the next measure, as we move towards the subsection climax. In the last two measures the SI reaches 2+. Overall, the subsection displays a greater SI fluctuation compared to the previous, and most of all, a greater average SI of 2+, which shows how the

[19] Let us note how in this case, a measure with a very high density such as measure 9 bears a very low SI, and vice-versa measure 1, with very low density, has a high SI, showing how density and instability do not necessarily go together.

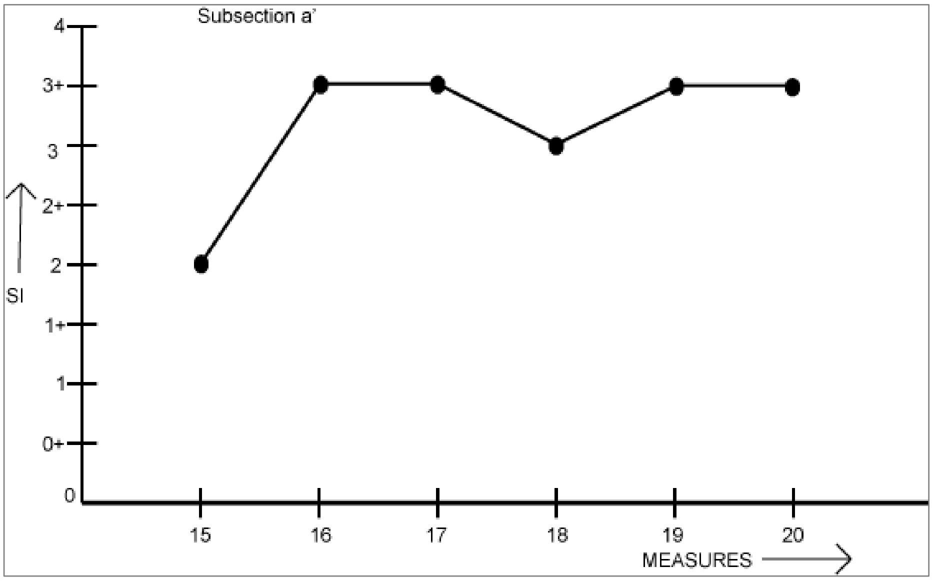
subsection is generally more unstable than a.



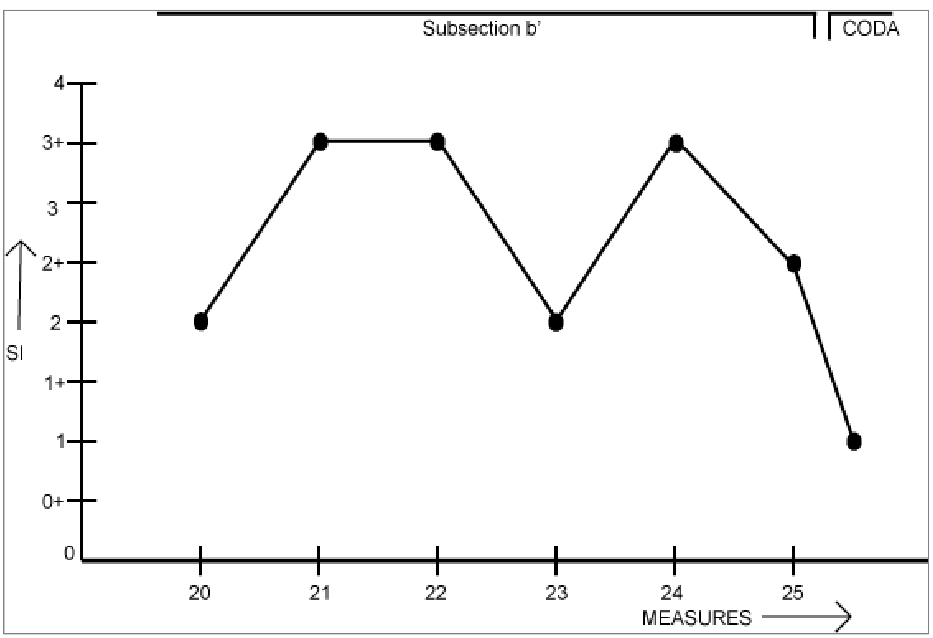
Example 2.8.5. SI graph of Subsection b of *Audible Ecosystems 3b.*

As we move to Section A', we notice a general increase of instability. As we mentioned before, in this kind of development it becomes much harder to perceive stable sonorities: indeed, even as they seek to appear, they are normally interrupted or “corrupted” by the intervention of unstable sounds. In this case, thus, there seem to be a correspondence with the increase of density and the increase of instability. This is particularly true for subsection a', which, as we can see from the graph, after a quick rise from SI 2 in measure 15, runs constantly at SI 3+. In certain cases, as in measure 16, the SI is near 4, being lowered only by the “water tube” instances. We could indeed identify the subsection's SI at 3+, which makes a' kind of complementary to a. However, there is a similitude in the continuity of the musical process, in the near flat SI, which reinforces the parallel between the two subsections. Example 2.8.6 shows the SI graph for subsection a'.

The last main subsection of the piece is also quite unstable in nature, as we already observed. However, this time in opposition to the density progress, it seems to struggle towards stabilization, and it is thus generally less unstable than a'. Example 2.8.7 shows the SI graph for b’

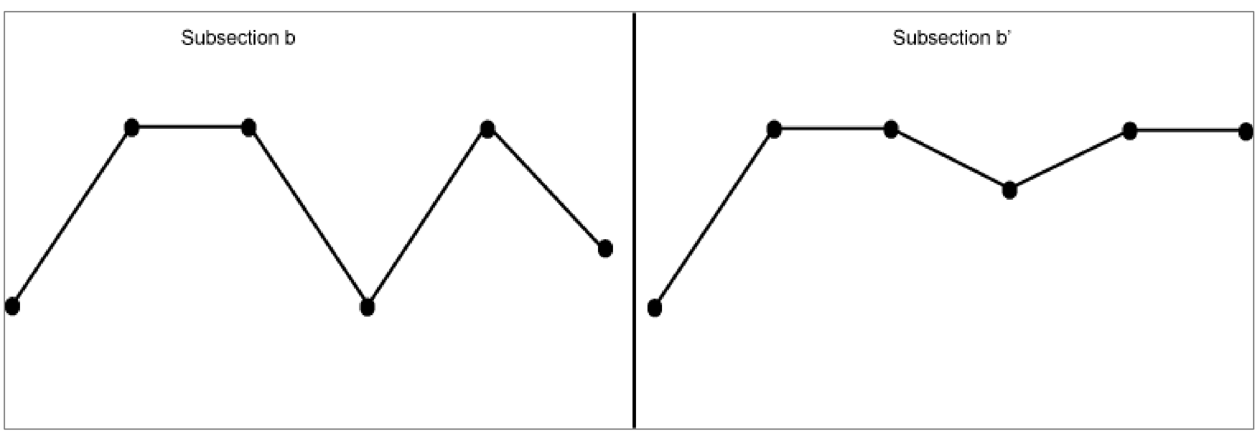


Example 2.8.6. SI graph of Subsection a' of *Audible Ecosystems 3b.*



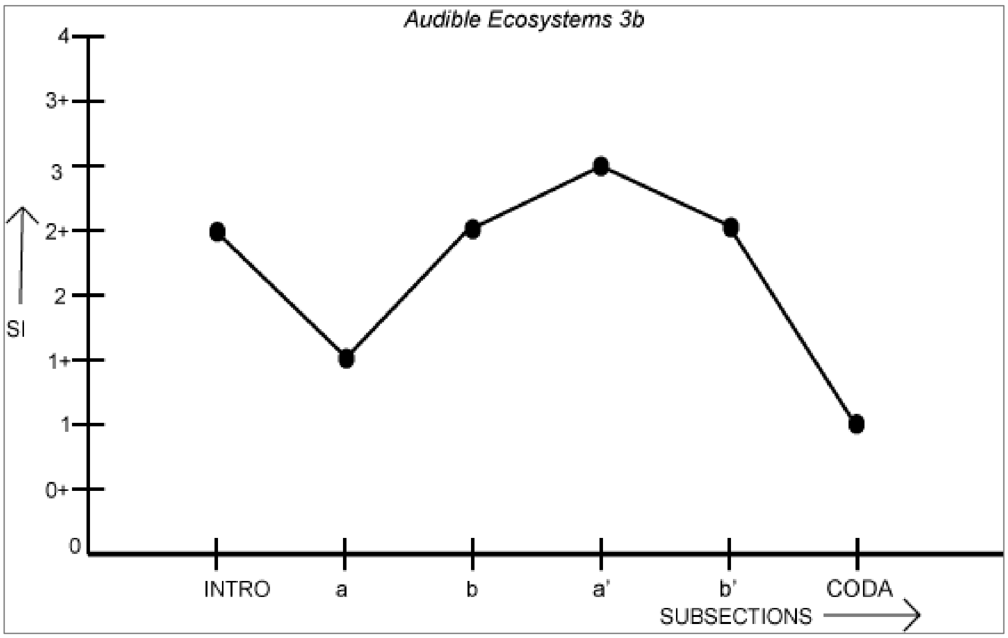
Example 2.8.7. SI graph of Subsection b' of *Audible Ecosystems 3b.*

As we can see from the graph, the subsection also starts with an SI of 2, quickly rising to 3+. However, in this case, as it can be seen in the transcription, the presence of sustained sounds seems stronger, and remains such until, in measure 23, the struggle for stabilization actually brings some results, dropping the SI immediately to 2. As we have seen in the detailed account above, this is the part where a texture change occurs, dropping the overall intensity and creating a prelude to the final rush. This is now reflected in the SI. In the next measure, however, things get back to “normal,” as the SI goes back to 3+, before finally dropping to 2+ in the last partial measure of the subsection. At this point, though, the bulk of the piece is already over, and we are into a kind of codetta. Generally, then, the overall SI of b is 3, and therefore we have a decrease from the previous subsection. In the b' graph I am including the graph for the CODA as well, since it occupies only one measure. The CODA is back to stability index 1. It would be a SI 0, if it were not challenged by the interventions of “click.” The contour of the SI graph for b', despite the general lower level, shows a striking similarity to that of b, with the initial increase followed by a sudden drop and the subsequent return to higher values. This reinforces the formal connection between the two subsections.



Example. 2.8.8. The SI graphs for Subsections b and b' next to each other. Note the similarity of their linear contour.

Having observed the graphs for each section, and the general SI index of each section, we are now able to create a “hyper-graph”, that is an SI graph composed of the SI's of the different sections. This graph is peculiar in that there is no = sign present. This means of course that the overall stability of the piece changes constantly between one part and the next. The SI graph for *Audible Ecosystems 3b* is presented in the following example:



Example 2.8.9. SI graph for *Audible Ecosystems 3b.*

It is possibile to use this graph to draw comparisons with the sections' graphs. Comparisons can be made in a few ways: first, searching for a one to one correspondence between the graphs operators and their subscripts: this is what in transformational terms would be called "isography",[20] and in some cases, especially in Di Scipio's case, may not be so fruitful, as given the nature of the piece the correspondence will hardly be exact. Another possibility is to relate the signs without great regards to their subscripts: this can shows a great similarity in the musical behavior, without resulting in an exact transformational replica. The last possibility is to

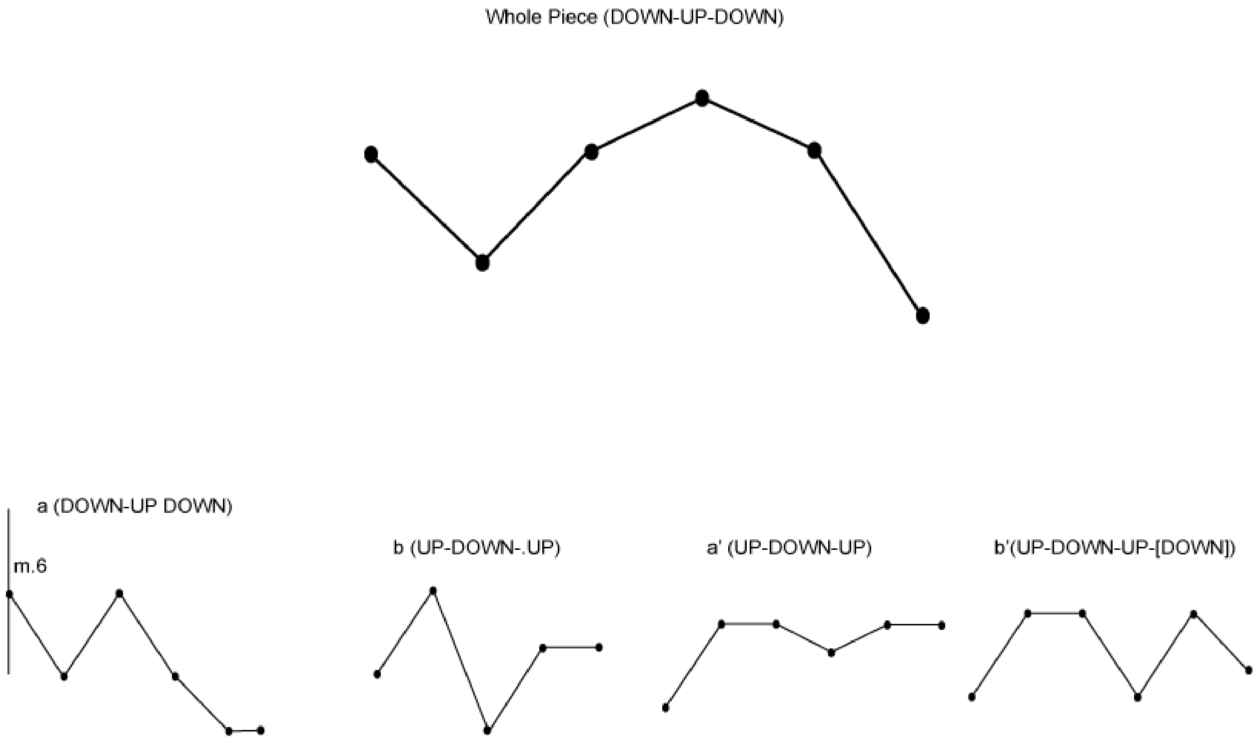
[20] See D. Lewin, *GMIT.* (1987, 2007). The difference, as we have seen, is that two SI graphs can also have identical elements, i.e. identical SI's, while relating potentially different passages.

be even less scrupulous by relating the general tendency of the passage, namely its graphic contour, while overlooking any exact correspondence in terms of subscripts of the operators, and times of occurrence of the transformations within the passage. The latter is essentially what allows one to compare sections of different length, such as a and a'.

The last method can be compared, in terms of process, to musical contour theory.[21] It is essentially the method I have used in the previous paragraphs to draw comparison between subsection graphs such as those of b and b' and a and a'. This method works with approximations, observing the most relevant oscillations in the graphs, and thus allows us to disregard = signs, unless they seem particularly present and relevant as comparison devices. Using this method we can see how the contour of the piece's graph diplays an DOWN-UP-DOWN motion (i.e. – + –), which is mirrored in the second part of the a subsection (measures 6-10, which is the most active part of the subsection in terms of SI, compared to the static first part), whereas the remaining three subsection display and inverted motion UP-DOWN-UP (+ – +). Example 2.8.10 shows the comparison between SI graphs.

Although, given the nature of the piece, assuming a strong analogy between the micro-structure and the macro-structure would be a bit far-fetched in terms of the SI graphs, through the example we can certainly draw a nice parallel between the two different architectural dimensions: if the piece as a whole tends to run towards a central instability climax, which is then followed by a descent into stability, at a smaller level it starts with a similar tendency, replicated in the first subsection, and then proceeds with an opposite behavior, that is creating less tension in the center while moving to an instability climax towards the end.

[21] See for example: Morris, Robert D. (1987) *Composition with Pitch-classes: A Theory of Compositional Design*. Yale University Press.



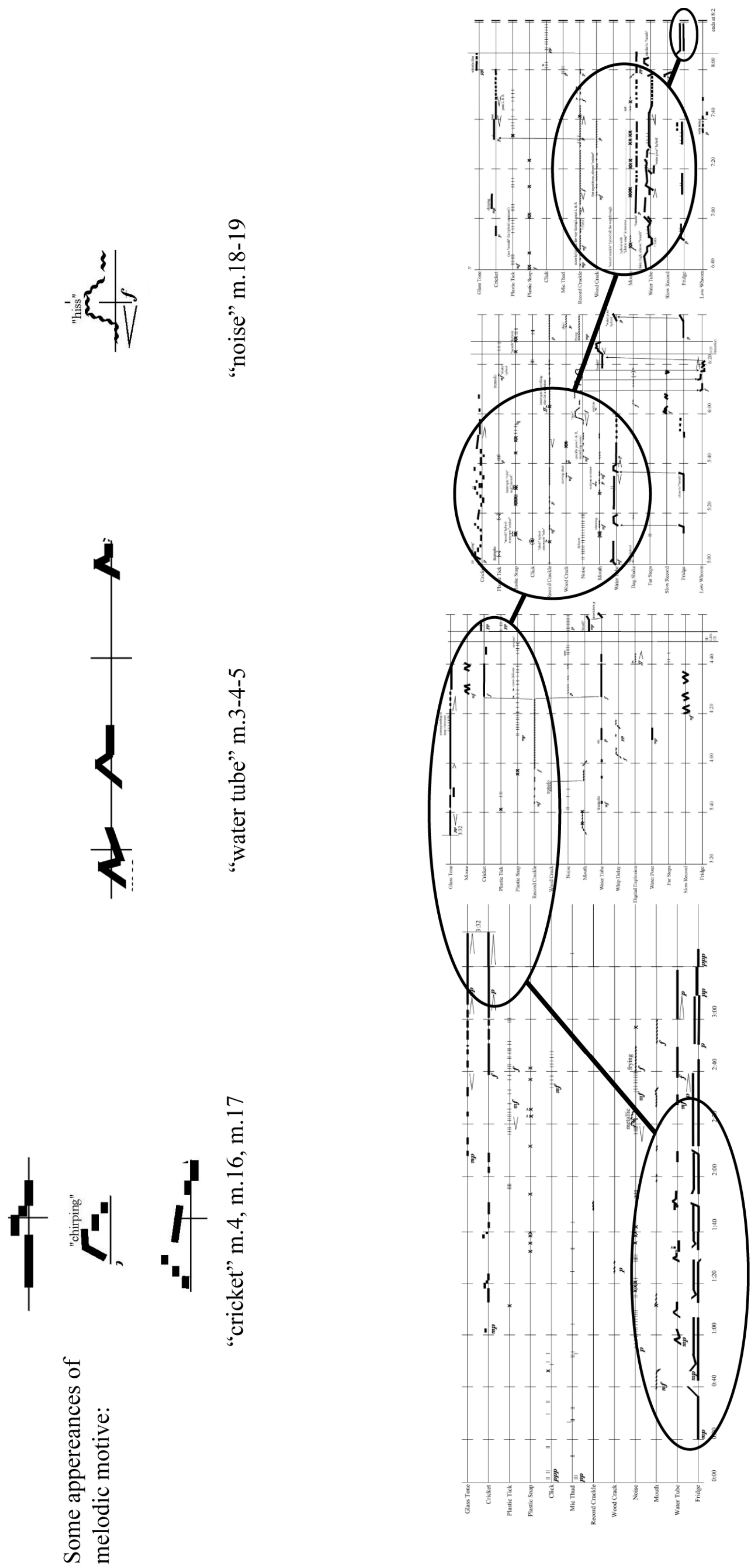
Example 2.8.10. A comparison between the SI graphs of *Audible Ecosystems 3b*.

2.9 Other potential analytical techniques and conclusion.

The transcription of *Audible Ecosystems* permits us also to perform an implicative analysis à la Stephane Roy (See Ch.1) It is of course beyond the point to undergo an entire implicative analysis of the piece at this point. But to show how this would be practically possible, an example can be made. As we have seen at the beginning of the analysis , the first subsection of the piece seems characterized by the “mouth”-”fridge” paradigm. Indeed, at least from a timbral point of view, as we hear instances of “mouth” we become acquainted to the follow-ups of “fridge,” so that, in a way, one could see the tension created by “mouth” released by the entrance of “fridge.” And similarly, the negation of the paradigm can be seen as a source of variety. The alternation of the two sounds, including their frequency shifts and their relative loudness and spectrum-type is clearly visible in the score, thus allowing us to easily engage in the task proposed by the Canadian scholar.

As a last analytical resource for Di Scipio's piece I will use the melodic motive we observed earlier in the step-by-step account. We have noticed for instance how “water tube” in measure 4 or 17, or “cricket” at the end of the same measure or in measure 16, or “noise” in measure 18-19,   move in the frequency domain by quickly rising upward and then descend to a lower level. This is the closest approximation to a melodic instance that we can find in this piece. It is, by all means, a kind of recurring motive. Its effect, however, can be observed further. Indeed, if we examine the overall frequency range of the subsections, meaning what sounds are more present in each subsection, and what frequency range they occupy, we will notice that the piece starts with a heavy presence of low to mid range sounds, then moves in subsection b to mid to high sounds, then slowly moves back down, at first with the mid range sounds of a', than with the mid to low range sounds of b', than back to low in the CODA. This of course corresponds to what was discovered by observing dominance patterns. However, we are now able to conclude that the overall frequency motion of the piece seems to be a large-scale deployment of the “melodic” motive above described. This is again easily visible on the score: one can simply observe in which part of the score (top or bottom or middle) there are more sounds active at any given moment. Example 2.9.1 shows a comparison between the melodic unit in question, and its large scale use.

At this point we have examined Di Scipio's piece quite in detail. The main intention of the chapter, and of this dissertation as a whole, is to demonstrate how a piece of electroacoustic music can be translated into a score-like transcription, which can enable us first to track changes



Example 2.9.1. The large-scale deployment of the melodic motive in Audible Ecosystems 3b. The motive’s contour is mirrored in the usage of frequency ranges in the piece.

and relationships with respect to certain parameters—for example, changes from timbral stability to instability—and then, armed with this data, construct a graph or map of the piece that reflects our musical perception of it. Indeed, the produced structural graphs resemble in many ways the analytical representations of a more traditionally composed piece. By this I mean that Di Scipio's piece resembles a piece by Webern or Bach, for example, in a meta-theoretical way, though not in a technical way. Indeed, when listening to Di Scipio, we can use the same low-level language to describe the process of apprehension as we do when listening to other, more familiar kinds of compositions. The piece discussed in this chapter was chosen as a the most difficult example I could find, as the epitome of the “hard to discuss musically,” and yet we have seen how, through the transcription, many different kind of analysis can in fact be performed on it allowing us to visualize and unveil several interesting structural features. Since *Audible Ecosystems 3b* has no notes, no rhythm, no real score, and it is not “composed” (i.e., putting together the different sounds at hand) in a traditional sense, any future attempt in discussing a piece that has at least one of these elements will be somewhat easier. Indeed this will be seen in the next chapter, dedicated to Douglas Henderson's *The Nature of the 103rd Thing (of 10,000)*.

Chapter 3
Transcription and Analysis of *The Nature of the 103rd Thing (of 10,000)* by Douglas Henderson

3.1 Introduction

In this chapter I am going to transcribe and analyze *The Nature of the 103rd Thing (of 10,000)* (*The 103rd Thing* from now on), an electroacoustic piece by American composer and artist Douglas Henderson. This will represent a second important case study and good testing ground for the ideas expounded in this dissertation, in that the piece's style is completely different from that discussed in the previous chapter. Unlike Agostino Di Scipio's piece, *The 103rd Thing* is a composed piece, thus more traditional in its approach. Indeed, Henderson's piece involves the use of the computer as a compositional tool, rather than a generative tool. The piece is created through a sequencing software, allowing the composer to layer sounds onto different tracks, as if they were notes on a score. This is a very different method from that used in Di Scipio's piece, in which the computer interacts with the performer, and the composer does not control the actual output, but rather the way, the process through which the output is produced by the computer. In *The 103rd Thing*, as in traditional composition, the output is predetermined and the compositional process is put into effect by the composer rather than by the computer, and no live interaction is involved.

This kind of approach connects Henderson with the tradition of "classical" electronic music composition, and with that of *musique concrète* for the use of sounds taken from real life. However, even though the originality of Henderson's piece does not come from an idiosyncratic manipulation of the technology at hand, as in Di Scipio's case, his compositional method is quite unorthodox, in that he is not much concerned with traditional compositional techniques, but rather with creating “an electroacoustic composition built to an architectural structure, rather than a musical progression. Physical forms moving and changing in time are modeled by spatialized sounds played through a four channel speaker system.”[1] As revealed in the composer's own description, the piece is originally written for four speakers, and the sounds' placement in space also plays a role in the perception of it. However, the recording is a remodeled stereo version that can be played back in any common sound system, and that is what I have used for the analysis. As in Di Scipio's case, I was not concerned with the strategy devised by Henderson to organize the sounds on the timeline, but rather with the structures that emerged from listening to the musical output.

As mentioned, because of Henderson's techniques the transcription of his piece would prove much faster than Di Scipio's. Having access to the software interface he used for the composition gave me direct access to most sounds that he used, and allowed me to locate where he used them. To make things even easier, the composer also provided a list, with descriptions, of all the sounds used. However, in order not to spoil the research, I accessed the material only after having made a preliminary hunt for sounds by ear. Having done that, I compared my results to Henderson's data. This proved quite interesting because it showed on the one hand a discrepancy between the number of sounds provided and the number of sounds heard, and on the other hand a correspondence between several sonorities and the labels provided.

3.2 The sounds of *The 103rd Thing*

The following is a list of the sounds I was able to retrieve by listening to a stereo version

[1] D. Henderson: *The nature of the 102nd thing (of 10,000) and of the 103rd thing (of 10,000)*, taken from the composer's website at www.douglashenderson.org/102103.html, accessed November 22, 2011.

of the *103^{rd} Thing.* The method applied to label the sounds is of course that outlined in the previous chapter.

1. "Roll": This is comprised of a series of random pulses that recall the rolling (or dropping) of fragments of hard materials inside a wooden box. It is a direct consequence of the initial shattering of glasses, whose shards are bouncing around in a box. It can be classified as a continuous but fragmentary texture, as opposed to a series of distinct pulses.
2. "Shatter": This recalls the sound of shattering glass, as in throwing a glass on the floor, or on another hard surface, non-resonating. Again, this is comprised of different elements, being the sum of all the glass shards separating from each other and subsequently hitting the surrounding surfaces, but it is perceived as one sonic event, being the consequence of a single act. Sometimes the composer alters the nature of this sound by changing its frequency, or by isolating the hits of single glass shards. Indeed, the sound can be very short, pulse-like, or longer, when it appears in its entirety, yet always unstable.
3. "Shards": This sound is a variation of "shatter." Sustained, but fragmentary in nature (due to its inconstant texture), it recalls the sound of large quantities of glass shards being moved about (as if mixing them in a box or distributing them on a hard surface).
4. "Noise": as in Di Scipio's piece, this is the typical noise (as in white or pink noise) sonority. Always sustained here. It is present for a long stretch of the composition, but it stays always in the background, following along the main sonorities of the piece almost as a side-effect.
5. "Knock": A pulse sonority recalling the hitting of a wooden structure with a hard object. This is often "colored" with reverberation (see "horn"), or can assume slight timbre

variation, as we will see. It is connected to “rolling,” not unlike the single hits of “shatter” being connected to the main sound, but it deserve solo status as it often does not seem a direct consequence of the rolling act.

6. “Fire”: a sustained sound with fragmented texture recalling the typical crackling of a fire place. Similar to Di Scipio's “record crackle”, but higher in frequency. Also related to to “shards,” but distinctively associable to a different source.
7. “Scraping”: recalling the sound of rubbing two paper pieces against each other. Texture is fragmentary.
8. “Horn”: Often appearing as a distant reverberation of “knock,” yet perceived as a different sound: a pitched, distant, reverberating car or boat horn, sustained but fading. It can change quite radically in frequency. When high enough, it recalls a high pitched sound such a screeching tire, rather than a horn.
9. “Tones”. Stable and pitched, a very simple and pure wave, almost a sine, but characterized by abundant reverb and pulsating envelope (as in a telephone busy signal)**.** Because it is made of a continuous stream of pitched events, it is perceived as stable in that the fragmentation along the time continuum is counterbalanced by the regularity of the impulses.
10. “Snap”. Pulse-like sonority (see previous chapter), slightly varying in timbre so to recall various materials clashes (e.g., metal against metal, plastic against plastic), and in morphology so to resemble a snap sound (as in closing scissors, or fingers snapping), rather than a ticking one. This is related to the hits in “shatter,” and probably it originates in the same way, but it fails to recall a typical glass hit.
11. “Bullet”: a derivation of the previous, but modified to be more sustained and swiftly

changing in frequency, with Doppler-like effect, as in a bullet passing by.

12. "Buzz": A sustained sonority recalling the typical 60Hz buzzing noise created in electric audio equipment. Appears first normally, then raised in frequency so to become more hissing in quality, closer to "noise."

The previous are sounds that are distinctively heard as separate entities in *the 103rd thing*. As we will see, Henderson did use in fact less separate sound entities to compose the piece, or at least we may say that he used a small amount of sounds, but the variations he created from them are in the end perceived as different sound entities due to the substantial differences from the initial form. On the contrary, due to fusion, the simultaneous use of two or more sounds may give rise to different percepts, which may make them appear as a single sound.

The audible sounds can be divided in three categories, as we have seen in chapter 3, 'stable', 'unstable', and 'hybrid'. The following is a list of all sounds in their respective categories.

a. Stable sounds (sustained): Tones, Horn.

b. Unstable sounds (pulse): Knock, Snap, Shatter.

c. Hybrid sounds (can be sustained, but either their texture is fragmentary, or can appear as pulses): Roll, Shards, Noise, Fire, Bullet, Scraping, Buzz.

Let us now look at the list of employed sounds and their description as provided by Henderson. The list overviews the sounds as they are used in the final session of the sequencing software:

1. "crinkles": the sounds left after scoring glass with a diamond cutter. Microscopic particles of glass thrown up by the cutter settle back onto the glass pane, these were heavily enhanced and I edited together all the instances of this, removing the scoring itself. They are then sent to 3 gated side-chains which drive 3 different comb filters with fast auto panners.

2. “crinkles filter”:the crinkle track enters with a descending high-pass filter, this is the printed version of the plugin automation.
3. “tone pod”: all the constituents of the track “tone submix”. the instantaneous tone produced as a wineglass is hit and shatters. All these tones were collected, edited together, and treated with [...] a granulator […]
4. “snaps”: individual glass cuts, the sound as I snap off the glass that has been cut with the diamond cutter.
5. “snap drop lib”: as I cut each piece I dropped it into a box. This is all those drops edited together.
6. “score dopple”: the sound of scoring the glass with the diamond cutter, recordings arranged and edited for 4 channel output, and extreme doppler shifts applied to higher amplitude sounds, between adjacent output channels.
7. “scrap dopple”: discarded sounds arranged and run through the same process as above
8. “DelPRT”: printed stem off the delay and reverb tracks applied during the submix assembly.
9. “shatter”: 75 wineglasses broken one by one and edited together, mixed with sifting of glass fragments in a box.

As we can see, Henderson provides also quite interesting technical detail on how he created the sounds, both in terms of physical gestures and of electronic manipulation. As in Di Scipio's case, the composer reveals his creative strategy quite in detail in terms of sound production (effects, filters, etc.). With regards to this research however, such information is irrelevant, as I am trying to determine what kind of musical discourse emerges from the deployment of such a strategy, rather than explaining how a specific sound was engineered.

Examining Henderson's list, we notice immediately a discrepancy between the number of perceived sound objects and the used sounds. If we consider that "DelPRT" is not a sound but rather an effect, we have a total of eight sounds compared to twelve found in the first list. We should note that what Henderson indicated in his list are more sound groups than actual sounds, at least in the sense that he also labels his sources intuitively, and that one label indicates the same source, rather than a single specific sound-event. In fact, Henderson's labeling method is quite similar to mine, even though he is pointing to the used source, rather than the perceived source. If we compare the two lists, we notice that some of the sounds are more or less the same. In some cases they even bear the same name. This shows that in some cases the source material and the percept correspond, and in some they don't.

In Example 3.2.1 we can see an image of the final session of *the 103rd thing* as it appears in the sequencing software[2] used by Henderson to compose the piece. As we can see the sound groups are visible in each track, but often appear more than once simultaneously, showing how the composer put the piece together, and how what we hear in the end is the result of a process of reinterpretation: we hear the basic flow of the composition as it appears on the software, but we split some tracks into different sounds, and we combine some tracks to form smaller units. This reinforces the importance of the transcription, even in a case where we have a lot of material showing the composer's organization of the piece. If we examine, for example, the 2 minutes line in the example, we can see how a bit prior to that point the composer engages in a change by eliminating the "crinkle filter" tracks and the "DelPRT" tracks, leaving the "crinkle" track playing as it already were. Although a change is indeed perceived at this point, what we hear is far from being a "removal" of sounds, leaving place to some that were already there, but rather a

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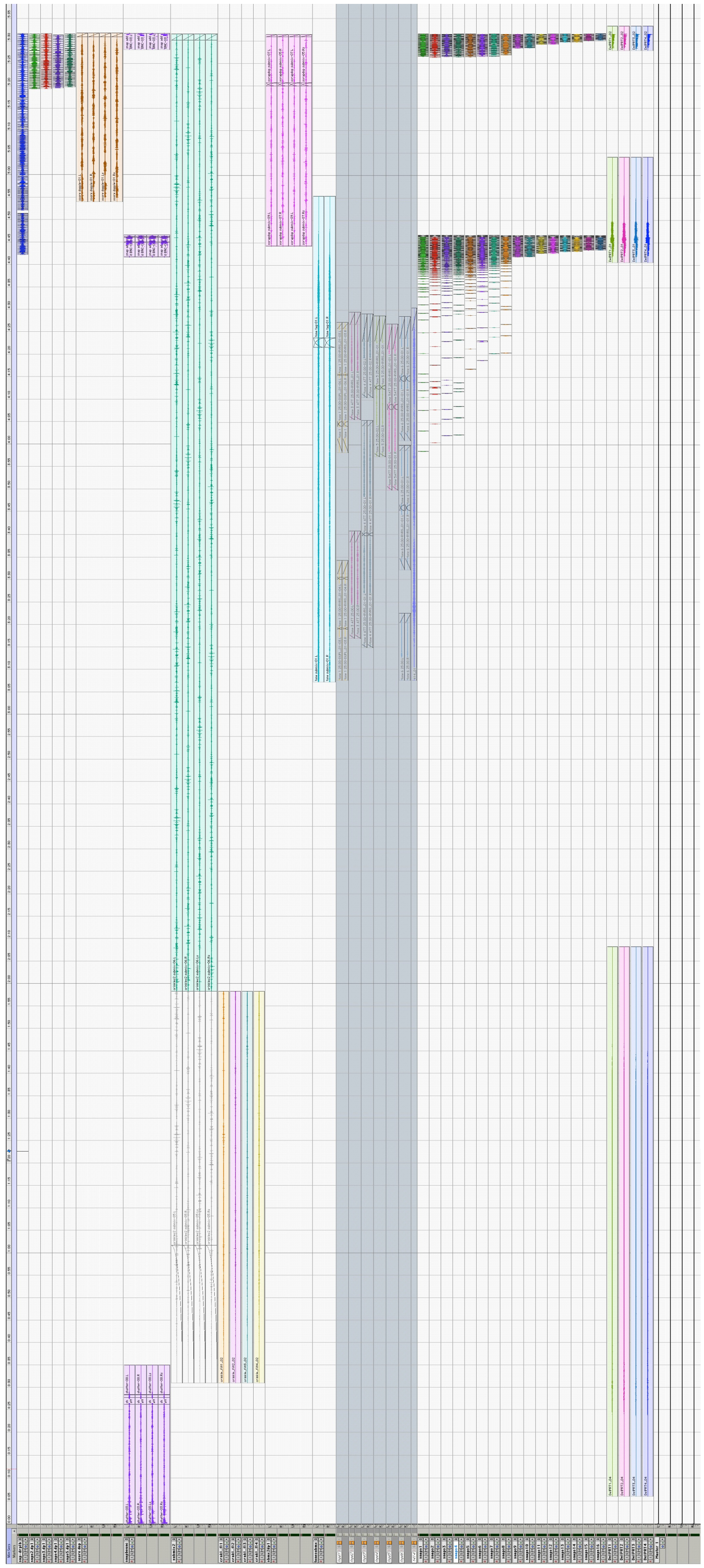
[2] The software in question is "Pro Tools" made by Disidesign Inc.

transformation, in which what was there before leaves room to something else. Moreover, we tend to perceive one main sound out of the several tracks prior to the 2 minutes brake, while we hear several sounds after the 2 minutes break, in contrast with what we see in the image. Indeed, such an image, just as much as a spectrogram, cannot be used alone as a basis for analysis.

On the other hand, the material provided by Henderson himself gives rise to an important question that is paramount to the very existence of this research. This question stems from information which is revealed by Henderson through his list of sounds. From this we can infer that all sounds present in the piece are produced by one single action: the breaking of glass. This means that the composer is exploring an explicit timbral theme, and he is using it to compose the entire piece as an element of overall coherence. However, since we do not hear of all the piece's sounds as coming from glass (or at least not consciously so), we could not deduct such information from listening only. Although it is possible to perceive continuity, a link between all sounds, it would be difficult to determine that they are all rooted in the same action without engaging in speculation. On the other hand, such information as revealed by the composer could be considered important at least from a formal point of view. What Henderson is telling us is that the piece is essentially written as a theme and variations. A special version, that is, of the old form: one where the theme built as melody or harmony, but as timbre, as sound. In this view, even sounds that may appear out of context at a first listening, more notably “pulsating tones,” are in fact derived directly from the act of breaking a glass (at the exact moment when the glass is hit, before breaking, it produces a very short tone), and thus fit perfectly in the piece design.

Just as a melodic theme is comprised of several notes, Henderson's theme has several sounds embedded in it. By focusing on one or some of these sounds at any given time, he creates texture changes that drive the piece forward and results in the formation of different sections,



Example 3.2.1. Snapshot of sequencing session for *the 103rd thing.*

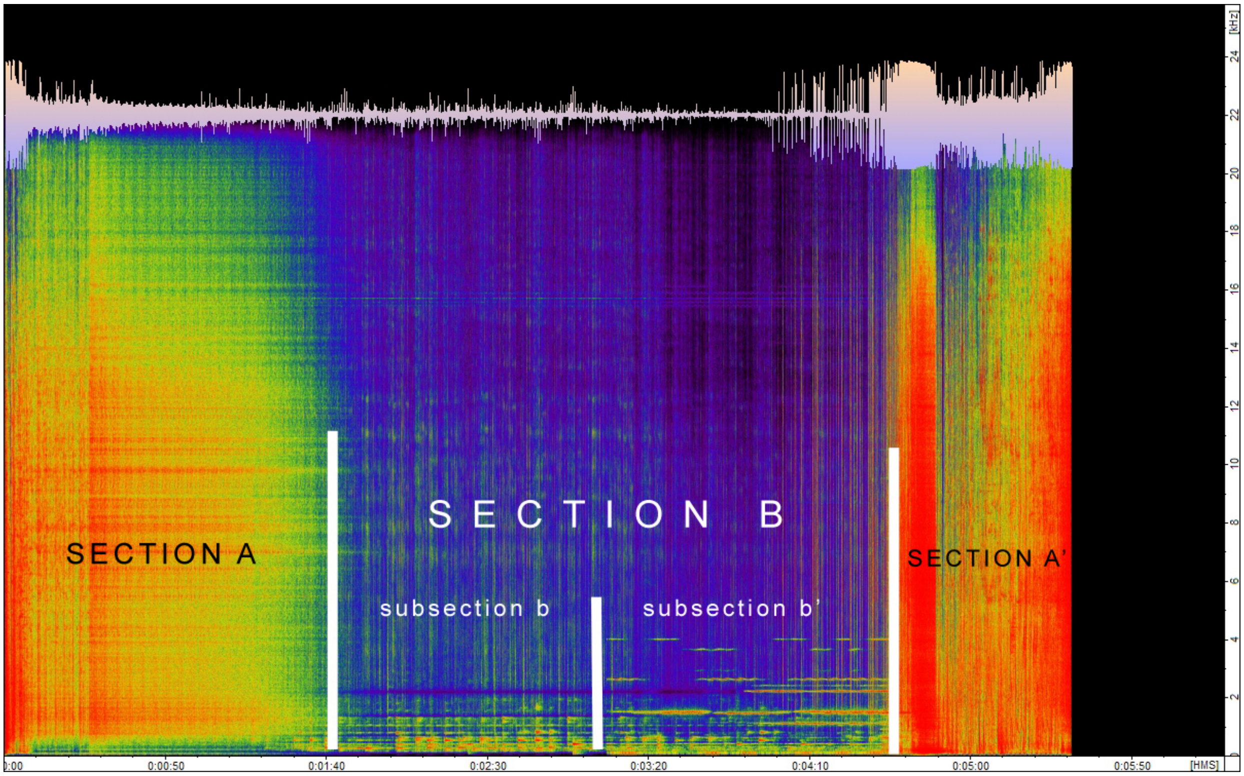
connected to each other by referencing the theme. Indeed, unlike Di Scipio's, Henderson's piece does not achieve coherence through the constant presence of certain sonorities, but rather through the common origin of the sounds used: if in Di Scipio the main timbral motive is recurring, thus gluing the piece together, in Henderson there is a basic motive that is transformed throughout the piece, and thus "hidden" from the surface.

After having been presented with such an important insight, the question remains whether we should take it into account during the analytical process. The answer to this would normally be negative, since this is a listening-based research. However, one could argue that this information does not revolutionize our perception of the piece (as it does not reveal any compositional, i.e., assembling insight), but rather implements it, by confirming something that is already subconsciously present, and that may push one to a similar analytical conclusion. I will here then attempt a middle solution: to keep my investigation on listening terms only, and towards the end use the information to implement my personal reading.

The analysis follows a similar process as that of the previous chapter, but I will avoid the detailed reading of the score, as it is assumed that at this point the reader will be able to do it by himself.

3.3 Transcription and Analysis of *The 103rd Thing*

Example 3.3.1 presents the spectrogram of Henderson's piece, realized with the *acousmographe* software as in the previous chapter. Despite having less evident breaks than *Audible Ecosystems 3b,* Henderson's piece can be divided in three main sections, suggesting some kind of ternary form. Such division is indicated in the example through white markings. As



Example 3.3.1. Spectrogram *the 103rd thing,* with formal segmentation markings.

one can see, the spectrogram's colors reflect quite well the audible partition in three sections. The following scheme presents the form of the piece based on the spectrogram-aided listening:

A (0:00-1:40 ca.) | B (1:40-4:40 ca.) | C (or A') (4:40-End)

b (1:40-3:00 ca.) b'(3:00-4:30)

As we can see, the B section is much longer than the other two, and occupies by itself more than half of the piece. Moreover, the b section is the only one that appears to be divided in two subsections. This can be seen in the spectrogram at 3:10 minutes, where some linear material appears, corresponding to the entrance of "tones." The entrance of pitched material can be considered relevant enough to justify the indication of a b' section.

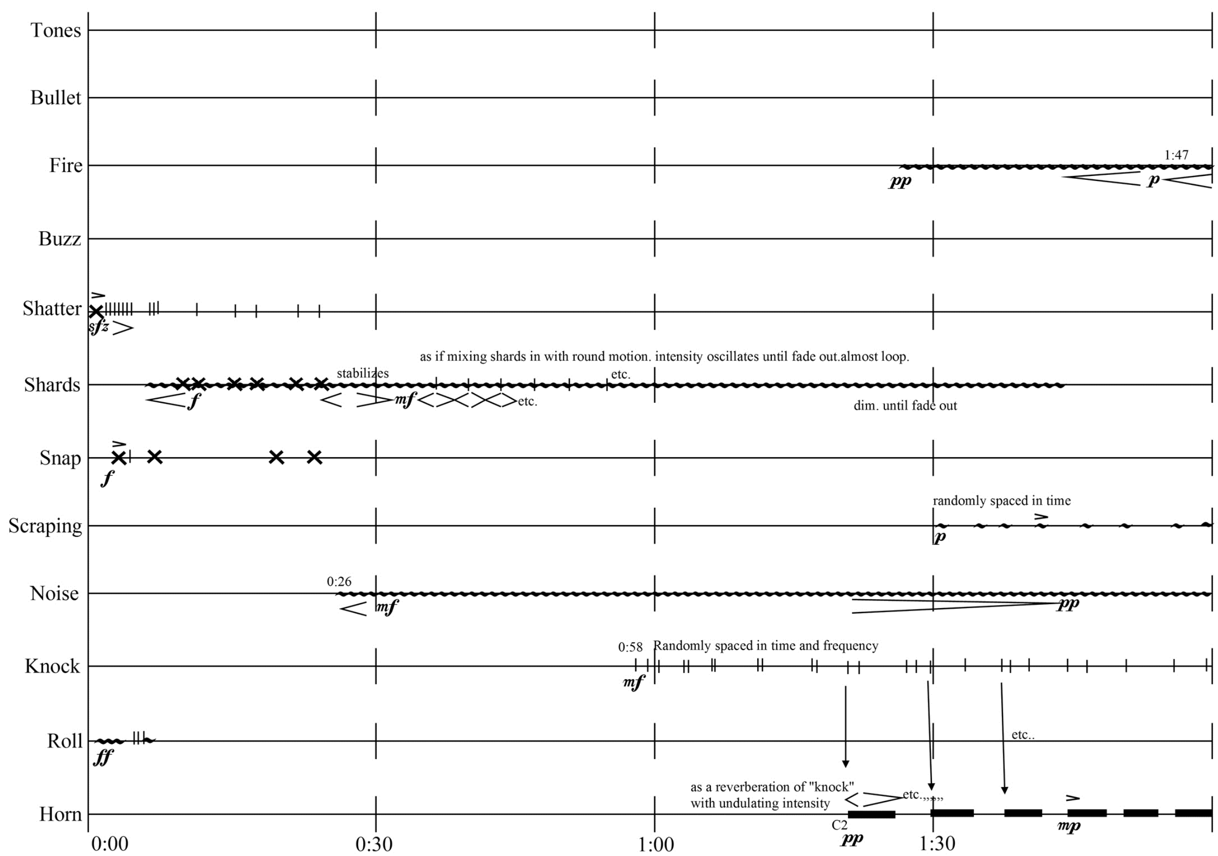
In the previous chapter we have examined some characteristics that formed the basis of the cognitive experience of Di Scipio's piece. Questions of stability, density/intensity, and dominance were approached to explore how the piece can be apprehended musically by a listener. One could argue that such characteristics are present in all timbre-based music, and *The 103rd Thing* is no exception. Indeed, even in this case they help us put the indicated formal segments into perspective: despite being much longer, the B section is not necessarily more prominent than the others, which seem to be more intense. Observing the spectrogram, the piece seems to follow a sort of inverted intensity arch, which links the outer section as being more intense (i.e., louder), and singles out the middle part as a kind of a resting point, more quite and subtle. More properly, rather than an arch, one could talk about an intensity wave, oscillating between states of calm and moments of higher intensity.

As I have mentioned, differently from Di Scipio's piece, Henderson's work does not provide precise breaks between sections, but rather transitional phases in which two sections overlap in a cross-fading: as material from the previous section slowly fades out, material from the new section slowly emerges until it takes its place completely. This can be somewhat observed in the spectrogram by noticing the progressive de-saturation (from red to blue/black) of the A section, and from the red spikes appearing in the b' section, which correspond to “snap” hits, that are so prominent in the C section. The appearance of “tick snap” can also be visualized quite clearly in the piece's sequencing section: in the lower tracks, labeled “snaps” we can see such occurrences from the fourth minute onward. The cross-fading technique utilized by Henderson gives a sense of smooth continuity, and most of all helps providing unity to the piece, which is not characterized by the constant reintroduction of previously heard sonorities.

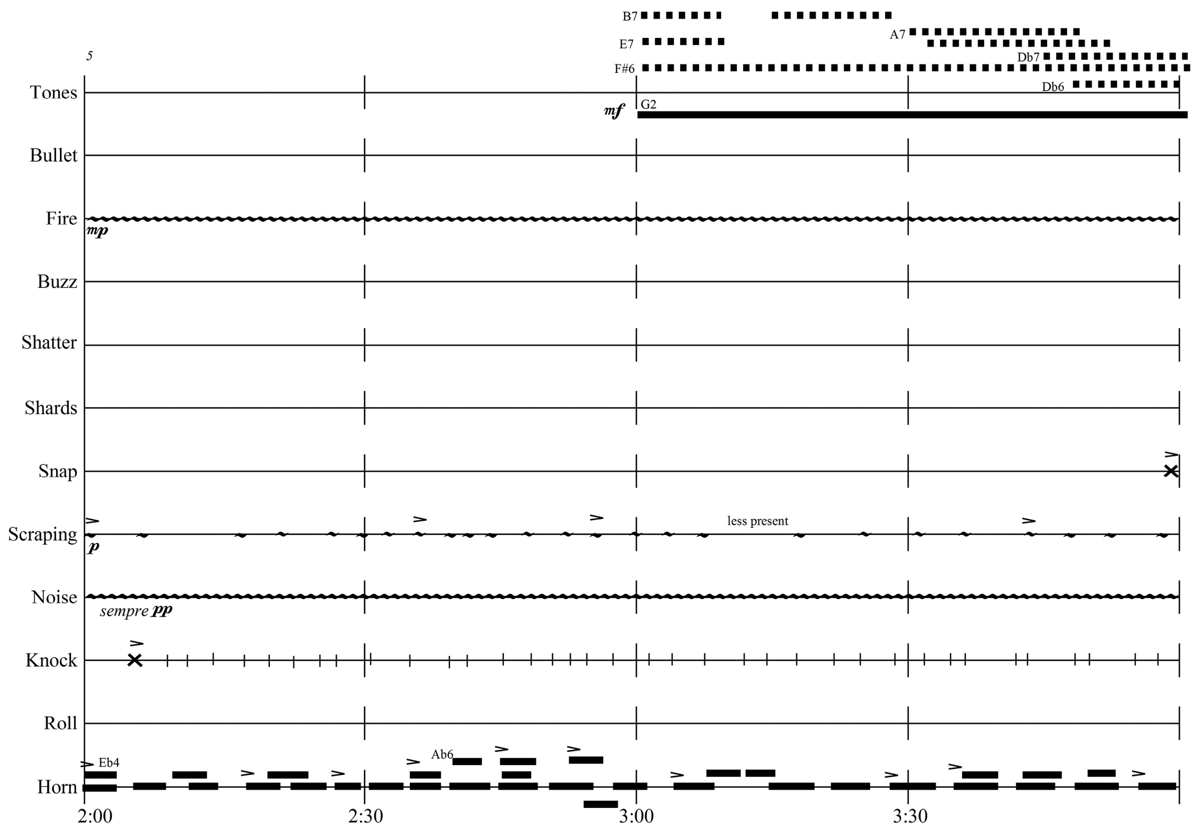
To better visualize the conclusions reached so far, we can now introduce the piece's transcription. This is shown in example 3.3.2. The “rules” to create this transcription are identical to those of the previous chapter. Even in this case I have separated the score in measures to simplify the reading. The length of each measure does not have a solid rationale as was the case for Di Scipio, but it is based on an approximation of important time-points in the piece: this lead me to a division in half minutes, so that each bar lasts thirty seconds.

The Nature of the 103rd Thing (of 10.000) by Douglas Henderson

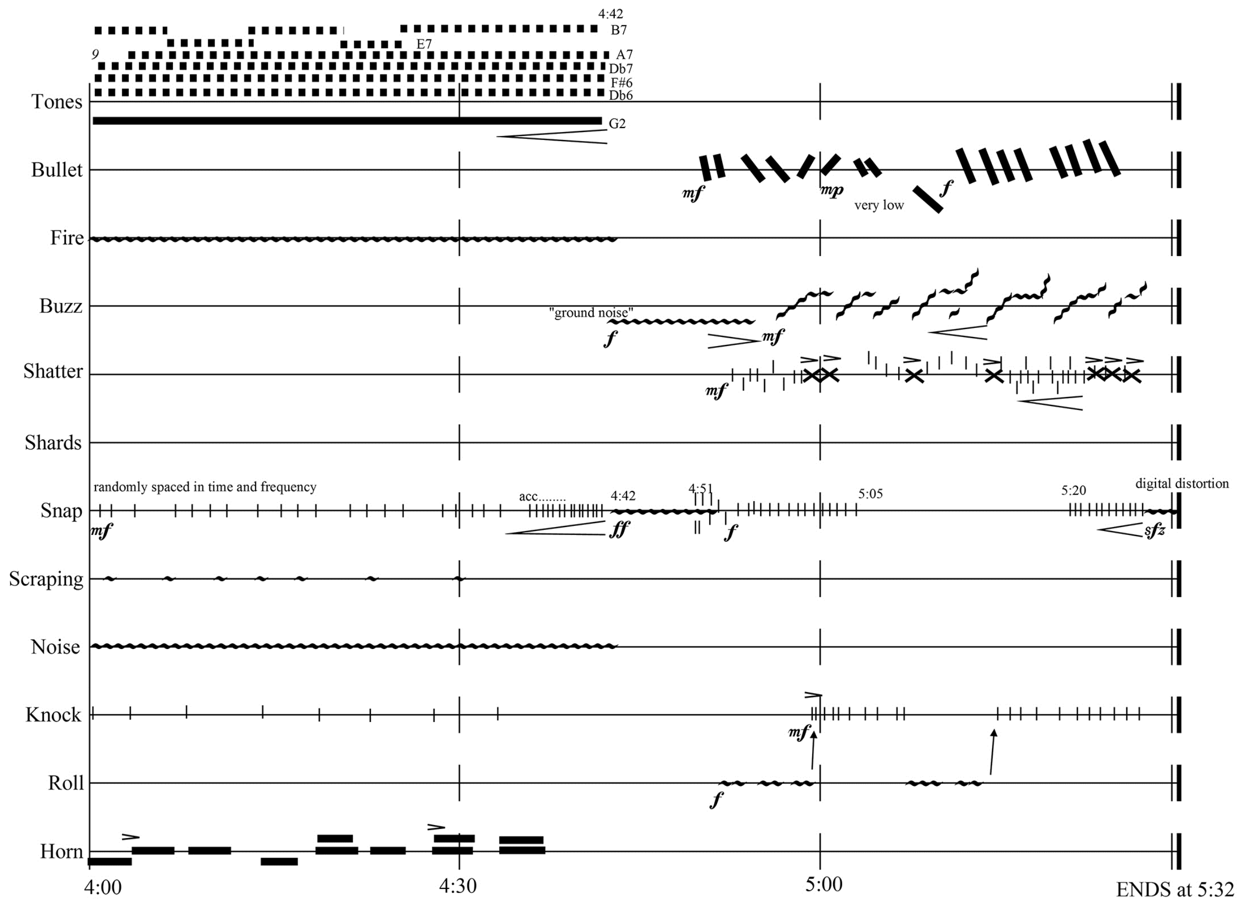
transcribed by M.Mazzoli



Example 3.3.2. Transcription of Douglas Henderson's *The Nature of the 103rd Thing (of 10.000).*



Example 3.3.2. Transcription of Douglas Henderson's *The Nature of the 103rd Thing (of 10.000)* (cont'd).



Example 3.3.2. Transcription of Douglas Henderson's *The Nature of the 103rd Thing (of 10.000)* (cont'd).

The basic traits of *The 103rd Thing* become quite clear in the transcription. Indeed, if we exclude the last forty seconds, the piece contains much less sudden textural changes than Di Scipio's, and the interventions of a specific sound tend to last for quite a long time, making *The 103rd Thing* a piece focusing on micro changes, on smoothness, rather than rapid and abrupt shifts. The transcription also confirms the traits observed in the spectrogram.

Let us observe, for example, how the material presented in the B section is almost completely different from that of the A section: the latter is loud and built for the most part around one very rich and clangorous sonority, “shards,” while the former is softer and focusing on the contrast between the destabilizing interventions of certain noisy sounds (such as “scraping”) and the stability of pitched sonorities like “tones.” In addition, the overlapping of the sections can be clearly seen, for instance, between measures 3 and 4. At this point the A section’s sounds start a long decrescendo, while the B section’s sounds are slowly and softly introduced, until they take over completely around the middle of measure four. Similarly, the b' section transitions into the A' section by way of introducing “tick snap” in measure 9, and gradually increasing its presence until taking over completely in measure 10, where the material of the B section disappears.

From the transcription it is also possible to visualize how several of the sounds characteristic of A come back in the last section. Because of this, it is once again possible to re-label a section, from C to A'. The A' section functions in fact as a kind of elaborated reprise of the material of A. This is quite easy to hear of course, but it can not be asserted with certainty just by looking at the spectrogram. It is thanks to the transcription that we can see the evolution of the A sounds into the A' section.

The most relevant feature of the transcription, however, is its ability to show quite clearly the most important characteristic of this piece, which relates to the metaphor of the wave mentioned above. Indeed, when we think about a wave (no matter what kind of wave, e.g., an ocean wave or a sine wave), we think about an entity exhibiting alternating states, with conditions of high and low affecting one or more parameters, characterized by smooth in-between transitions and often balancing each other out: an important metaphor for Henderson's piece, in that a constant alternation of states is in effect what drives the piece forward. Alternations of different kinds are of course common to most musical languages, and were observed in Di Scipio's piece as well, in the juxtaposition of stable and unstable sonorities, resulting in certain level of stability that was described as Stability Index. The main difference is that while in Di Scipio this aspect only affected the textural differences between one sound and the other, and it wasn't characterized by smooth transitions, in *The 103^rd^ Thing* there seems to be a tendency to move between alternate states at many levels of the compositional endeavor, from the morphology of the created sounds, to the large scale organization of the piece.

We have already observed how the intensity alternation between sections affects the large scale organization of the piece. More specifically, we can see how the first section is characterized by very high dynamic levels. Indeed, the piece begins with a fortissimo instance of "shatter," followed by a forte passage of "shards," which is itself punctuated by accented hits. As we reach the second measure "shards" stabilizes and descends into a mezzo forte, but this is accompanied by the entrance of "noise," making the overall intensity higher.

Transitional sonorities such as "fire" and "horn" enter pianissimo, anticipating the overall tone of the second section. When this begins, in measure four, we can only observe sounds playing in a range from pianissimo to mezzo forte. Indeed, this corresponds to the dynamic range of the section. Even in the second part the range remains the same, if we exclude the accented hits of “snap” at the end of measure 8, which in effect constitute a transition into the final section. Despite the general soft volume of the section, however, it is possible to identify small intensity surges at the very beginning and end of it. This is due to the accumulation of more sonorities (trailing away from the first section in measure 4, and the addition of “tones” and “spoon” in the second part), which do not necessarily posses a higher intensity *per se*, but contribute to the overall perception of increased volume.

The dynamic range of the A' section, on the other hand, is quite the opposite: from mezzo forte to fortissimo, just like the A section. Starting and ending with fortissimo instances of “snap,” the section is characterized by a middle section with softer sounds, but still very high perceived intensity, due to the accumulation of multiple sonorities.

The intensity alternations thus provide a bridge between the A and A' sections and form a large-scale projection of the wave motive. This sense of wave-like motion is heightened by the smooth transition between the sections. Indeed, as we have already observed, the first section slowly fades out leaving space to the material of the second. Similarly, the B section increases in intensity through the interventions of “snap”, and towards its end goes to a fast crescendo that brings us to the beginning of the A' section, so that the boundary between the two is softened.

As I have mentioned the wave motive is as important for the larger architecture of the piece as it is for the creation of the single sections. Indeed, if we look at the first section we will notice that it is primarily based on one long stretch of “shards,” which fills the section from measure 2 until its end. “Shards” is a compound sonority, formed by all the sounds that a gesture like moving glass shards in a box entails (like “mouth” in Di Scipio's piece). Around the end of measure 1, however, it is stabilized in a kind of fixed gesture that alternates roughly every three-four seconds peaks of higher intensity to stretches of lower intensity, as if the motion of the hand moving the shards about were not constant, but heavier and/or faster at times[3] The effect created is really not unlike that of sea wave, moving back and forth creating the typical oscillating intensity pattern. Henderson, however, avoids repeating the gesture at equally distant time-points, as in a loop. This helps creating variety, avoiding a stalling effect. Despite its relative stabilization, indeed, "shards" still remain a quite complex sonority, filling almost the entire frequency range with a plethora of ticking particles, a quite turbulent sonic mass.

The second section is dominated by three sounds: "horn," "tones," and "fire." Despite being morphologically different, all three display wave related characteristics. "Fire," which is the noisiest of the three and is completely pitch-less, appears as a sort of a "leftover," filtered version of "shards," in that it seems to occupy a small, higher frequency range and is much softer, but it is still formed by rapid successions of noisy pulse-like elements, like "shards." Indeed, it shares with it an inconstant intensity behavior, which can be reminiscent of a wave motion, even if the succession of intensity spikes seems much more randomly distributed than in "shards."

"Horn," on the other hand is a relatively pitched sonority whose deployment is not continuous but appears at almost constant time intervals. It consists of short (around three-four seconds) instances characterized by an envelope with slow attack and even slower release. This also creates a wave-like effect in the sound intensity, reinforced by the moments of silence immediately following the instance.

Lastly, the morphology of "tones" is related to that of "horn" in that it consists of very small instances (about ½ of a second) of clearly pitched material separated by silence. Because the instances repeat quickly and constantly, one has almost the feeling of hearing a continuous

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[3] One should imagine as a comparison, the typical brush motion of a jazz drummer. The rotation of the hand of the snare drum is not constant, thus creating peaks of intensity that follow the piece's rhythm.

sound, but the perception of oscillating intensity—again our wave-like pattern—is nonetheless definitely present.

In the third section, which differs from the previous two primarily for the lack of stable sounds—if we exclude the beginning and ending instances of “snap” that is stabilized into a continuous conglomerate of pulses—the wave motive does not appear as an image of some sound's amplitude behavior, but rather, as it would be more common in pitched music, as a metaphor of frequency movement. Indeed, if we observe the motion of “bullet” and “electric buzz” in measure 10 and 11, we will notice that it consists of downward glissandos for the former, and of upward glissandos for the latter. Although the two sounds do not always alternate, and sometimes appear simultaneously, we could say that their up-down movement in the frequency domain also mimics the motion of a wave, in that it smoothly fluctuates between opposite states.

As I have noted in the previous chapter, intensity and density do not always go together. More specifically, concerning Di Scipio's piece I have noted how increases in density are often but not always mirrored by an increase in intensity. In Henderson's piece this is even less the case.

I am again using the term “intensity” to refer to the perceived loudness. On the other hand, I use the term “density” to refer to a combination of elements, namely number or sounds or voices playing at the same time, rhythm of the passage[4], and occupied frequency range: the higher the value of these elements, the higher the density. The only section of *The 103^rd^ Thing* that exhibits high density and high intensity is the third. The lack of stable sounds, the fast pace, the amount of simultaneous sonorities, and the clangorous nature of them, makes this section

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[4] Rhythm is used here in a general sense: the speed of succession of instances of one or more sounds. No regularity is implied.

very dense.[5] The previous two section, however, are in state of equilibrium with regards to density. Despite a dense outset, the A section soon settles to a slow pace with few but clangorous sounds involved. The B section is also slow paced, and less clangorous in nature; the number of sounds playing together is however higher than that of A. Also, because of the polyphonic nature of the pitched sounds of B, the number of voices is even higher, thus heightening the sense of density. When "tones" comes in, we have over 10 different voices playing at the same time, compared to a maximum of 4 in the A section (6 if we include the transition). Because of these factors, we could say that A and B have a similar density level, in neither case being very high.

Let us now observe the dominance pattern of *the 103rd thing.* The following table presents the dominant sounds of the piece. It is read in the same way as that of chapter 3.

Sections / Rank	A	B b	 b'	A'
1	"Shards"	"Fire" "Horn"	"Tones"	"Snap" "Shatter"
2	"Shatter" "Roll"	"Knock" "Scraping"	"Fire" "Horn"	"Bullet"
3	"Knock"	"Noise"	("Snap")	"Knock" "Roll"
4	"Snap"		"Knock" "Scraping"	"Buzz"
5	"Noise"		"Noise"	
6	("Horn") ("Fire")			

In the table, sounds in parentheses are transitional sounds, so they don't really belong to the main textural ground of the pertaining section. Nonetheless, "snap" in section b' is quite loud and therefore present in the foreground, thus becoming a quite dominant, albeit rogue sonority in

[5] As we have seen in Di Scipio, High density combined with high intensity tends to create a chaotic effect. Indeed, in the conclusion of his piece Henderson seems interested in creating a "firework" ending, a kind of *Gran Finale* counteracting the calm of the previous section.

the subsection.

A quick look at the table confirms the connection between A and A' and the status of divider of B, whose sounds are almost entirely different from those of the other two. Indeed, there seems to be only one exception. Only one sound carries through all three sections: “knock.” This sound, however, averages a third position in the dominance rank. This makes it, at least on the surface, a secondary sonority throughout the entire piece. One could therefore not assert “knock” to be the central sound of the piece, as it was for “water tube” in *Audible Ecosystems 3b:* its position is too far in the background, so it can not be heard as the carrier of the piece overall color. However, it does stand out as a unifier in a piece where the general timbre appears to shift quite radically from one section to the next.

The table reveals how the first and last sections are comprised primarily of clangorous sounds. In both of them, the sense of the main sound-producing material, glass, is very much present. The central difference lies in their stability, since A is dominated by a sound that appears primarily in a stable form, while A' exhibits a turbulent assemblage of short or erratic sounds. The first section's pillar of stability, “shard,” is not only non-dominant in A', but is altogether missing. A', indeed, has no stable sound, and the ones that could potentially be stable are destabilized by glissandos. In general, A' focuses on sounds that were only briefly introduced in A, or that occupied a secondary role. One should for example look at the role given by Henderson to “snap” in A', where it becomes the most dominant sound, while in A it occupies the fourth position. Additionally, the two new sounds introduced in A', “buzz” and “bullet,” are in effect variation of “noise” and “snap” respectively.

Contrary to the outer sections, the B section is comprised mostly og stable sounds, and most of all, by pitched sounds or clangorous sounds with narrower frequency bandwidths. This entails that arriving to B the composer decided to remove the roughness of the previous section by concentrating on lighter sounds. This factor, along with the softer dynamics, is responsible for the overall perception of calmness associated to this part. In section B, glass as a source material is nearly inaudible, at least on the surface. However, as we have seen it is possible to hear "fire" as a reduced version of "shards," creating, along with "knock," a connection with the previous material.

In this section, Henderson seems more concerned with exploring the frequency domain. This is confirmed by the two most dominant sounds of the section, "horn" and "tones," which are pitched in nature. "Horn," is in a way less powerful than "tones." Not only it is not so clear in pitch, but it is also very often tied to "knock," which sounds almost as "horn's" determining event.[6] When "tones," comes in, however, it creates a shocking contrast compared to the beginning of the piece. It is indeed worth spending a few words on the notes brought about by the two pitched sounds.

"Horn" exhibits primarily three pitches: C2, Eb4 and Ab6. The C is in effect a quarter tone lower than normal instrumental tuning. These notes give to b, the first part of the B section, a general minor mode aura, in that the very high Ab is perceived as a a kind of suspension to the implied triadic note G. It is of course unlikely that Henderson was purposefully seeking to create a tonal harmony in this piece, and it seems more feasible to think that the result is serendipitous, perhaps driven by the isolation of partials of the lower note. This last hypothesis seems to be confirmed by the entrance of "tones."

The pitch pattern of "tones" is much more elaborate than that of "horn." At its start "tones" has four voices playing simultaneously, the lowest of which is a G2 (tuned at 100Hz, a

[6] When this happens, one perceives "horn" as a consequence of "knock," as if it were determined by the resonances in "knock's" reverb.

bit higher than classical tuning). This note is actually the only one of “tones,” that is not pulsating, but continuous. All the other notes partaking into the formation of the polyphonic units are high multiples of the lower frequency (e.g., F#6 at 1500Hz, E7 at 2600 Hz, B7 at 4000 Hz etc.). Rather than exhibiting a specific chordal pattern, indeed, it seems that the composer was interested in using upper partials of the lowest note to create a complex harmonic spectrum. Nonetheless, one cannot avoid noticing the fifth relation occurring between the bass notes of the two sounds (C2 and G2), almost as if the composer had wanted to delve into the remnants of the past.

Earlier in the chapter I have explained how Henderson's piece constitutes a kind of theme and variations, the theme being the action of breaking glasses, and its related sound. As we have seen, this is clear insofar as certain sounds are *de facto* perceived as variation from their statement at the beginning of the piece. This idea of variation becomes however more problematic in the B section, in that the only sound clearly derived from earlier ones is “fire.” This is thus the point in which Henderson's own insights become analytically viable. We know from Henderson himself that there is a connection between “tones” and the clearly glass driven sounds of the piece(e.g. “shatter”): as I have explained earlier the “tones” are derived from the glass hitting the surface right before shattering. Taking now this information into account, we can conclude that the B section is a sort of investigation of the inner sounds derived from the main gesture of breaking glasses, while the outer sections are concentrated on the surface sounds, those that do not need filtering or heavy manipulation in order to be audible.

More specifically, we could envision the piece as proceeding in the following manner: from a first statement of the complete sound theme (breaking glass, comprised of four separate sounds “shatter,” “roll,” “snap,” and “shards”) in measure 1, we move to a first investigation of the sound that forms the second part of the source (shards bouncing around) in measures 1-4. Then the focus shifts on the details of the source (embedded sounds not perceivable at first) in measures 4-10, and finally we go back to the surface of the source, but varying now the first part (the hitting) in measures 10-12. The following scheme shows the form of the piece interpreted as a theme and variations:

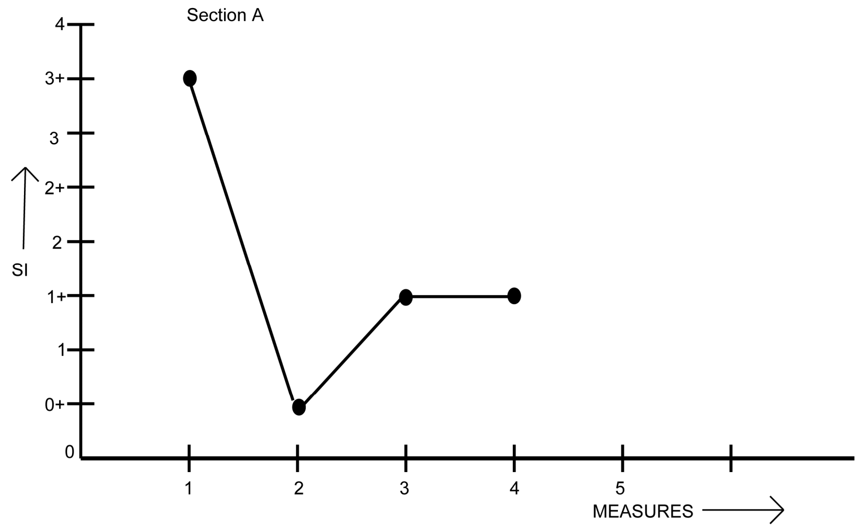
Theme	| Var. I	| Var. IIa	—	Var. IIb	|	Var. III
m.1	mm.1-4	mm. 4-6	—	mm.7-10		mm.10-12

3.4 Analyzing *The 103rd Thing.* The Instability Index.

An analysis of the *The 103rd thing* through the Instability Index seems to come in support of interpreting the piece as a theme with variations. As I did for Di Scipio's piece, it is indeed possible to establish an SI for each measure of the piece, thus allowing us to observe the network of SI transformations at both the local and the global level.

In Henderson's piece SI's tend to not oscillate much within sections. This is due to the composer's style, which does not rely so much on a timbral tension-release contrast, but focuses on long sound stretches and smooth transition to concentrate on the textural variations as described above.

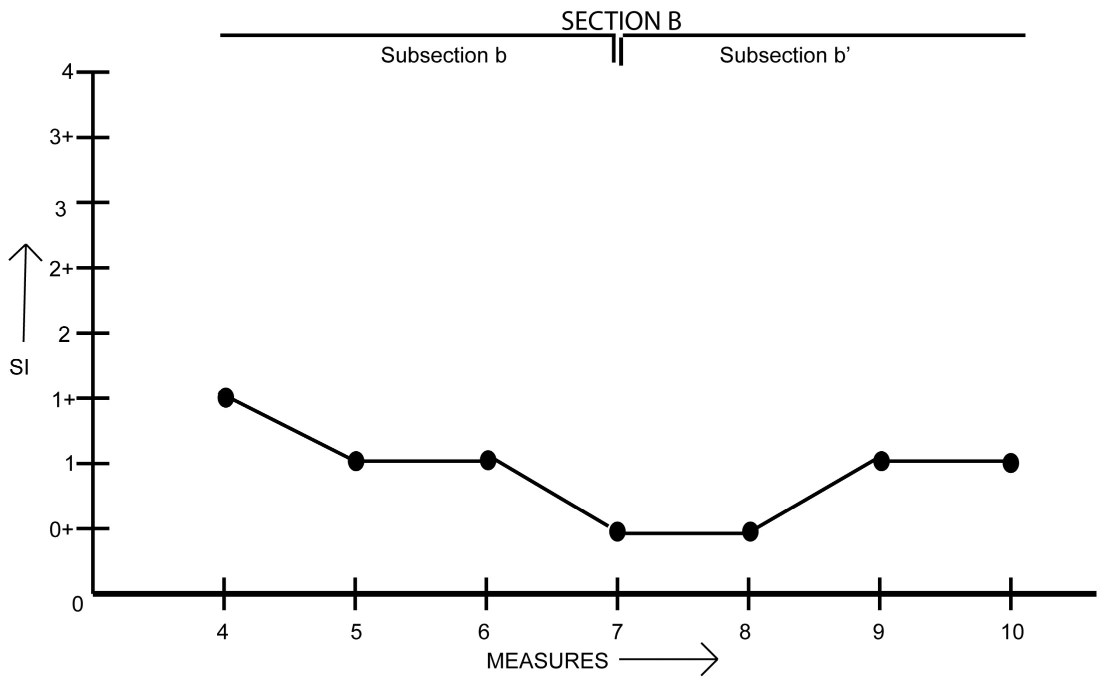
Example 3.4.1 presents the SI network of the first section of *The 103rd thing.* One notices right away how the piece starts in a very unstable way. This corresponds to the statement of the theme, which is comprised mostly of unstable sounds. It is an almost completely unstable measure, if it weren't for the late stabilization of “shards” and the introduction of “noise.” After this, the SI drops suddenly to a 0+ degree. It would be 0, if it weren't for the interventions of "knock" at the end of the measures, and for the fragmentary nature of "shards." In measure 3 rises to 1+ because of "knock," and so it stays until the end of the section.



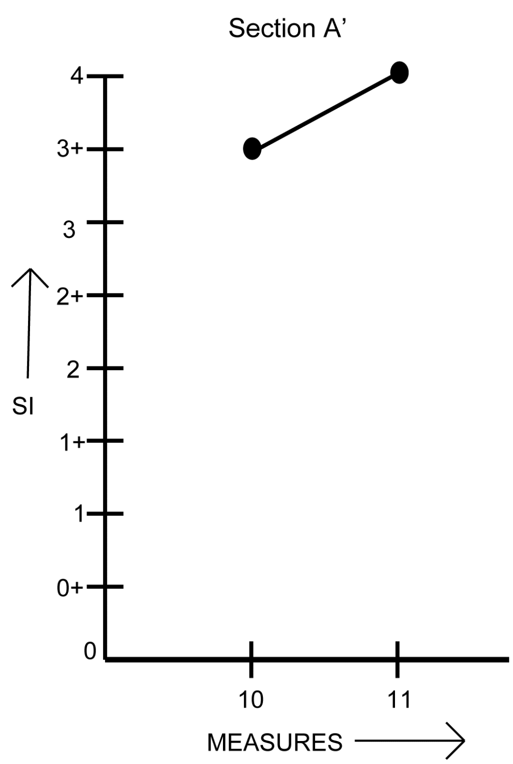
Example 3.4.1. SI Cartesian graph of section A of *The 103rd Thing*.

Example 3.4.2 shows the SI graph for the second section of Henderson's piece. Not surprisingly, it displays overall a very low SI, which gets a somewhat higher in the transitions because of the mixing with material from A and A'. Indeed, starting from a 1+ index in measure 4, we drop to 1 in measure 5 to a near 0 in measure 6, corresponding to the entrance of "tones" into the picture. Only when "snap" comes back, we reach back to SI 1.

Example 3.4.3 finally shows the SI graph of the last section. Since the beginning of the section in measure 10, the SI climbs directly to 3+, showing a very unstable passage. The passage is nonetheless slightly more stable than what follows in view of the presence of "buzz," and to an extent of the stabilization of "snaps," in which the occurrences of the sound are so close to each other so to form a single conglomerate of pulses. In measure 11, which constitutes the bulk of the short finale, one can not find a single stable sound. The SI of this passage is 4, and it goes along very high density and intensity, expanding in effect what happens at the very



Example 3.4.2.The SI graph of section B of *The 103rd Thing*.



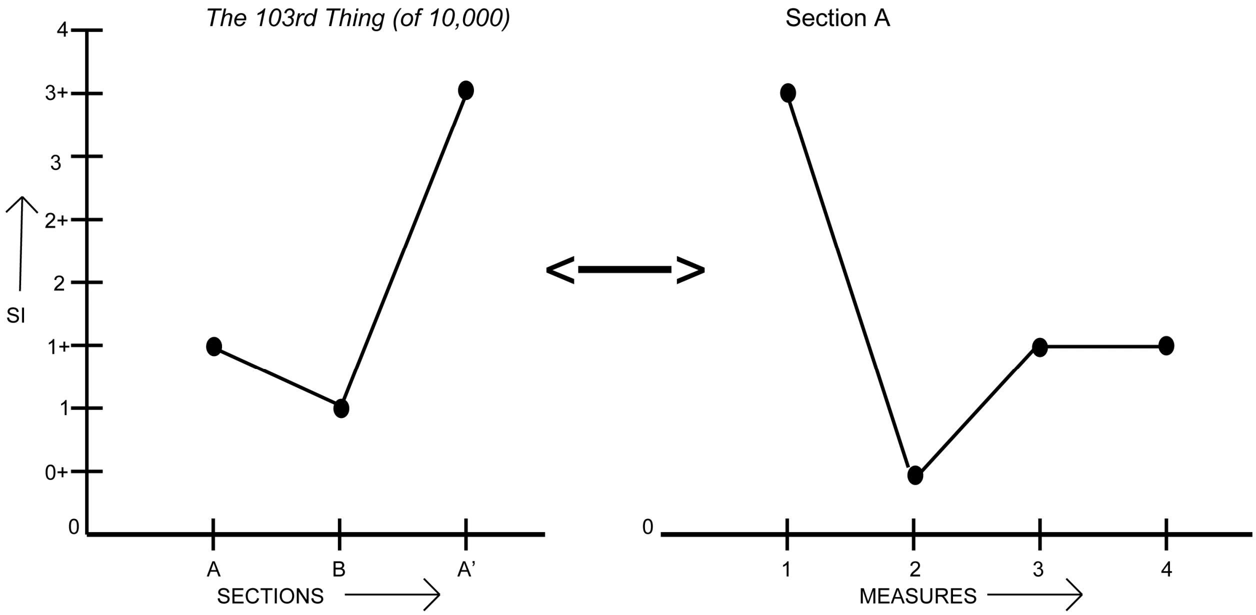
Example 3.4.3. SI Cartesian graph of section A' of *The 103rd Thing*.

beginning of the piece.

I should note that the piece concludes with another 'stabilization' of “snap,” although this is too short (2 seconds) to affect the SI. This ending however, mirrors the opening in reverse: as we had a very sharp attack in measure 1, and the piece began with a *sforzando*, we have now a *sforzando* finale, only with a very sharp and sudden release. As we did in the previous chapter, we can now determine the SI network of the entire piece by averaging the SI of each section. What the SI graph of *The 103rd thing* shows is a 'soft DOWN- sharp UP' motion indicating the peculiar status of the third section. The beginning measure slightly raises the average for the first section, but does not affect it much. If we compare the piece's graph to that of the first section, however, we will notice how the former appears to be an almost perfect retrograde of the latter. This emphasizes the connection between the piece's end and its opening, and seems put the above described retrograde relation into a broader perspective: the entire piece as a retrograde expansion of its first section, at least from a stability standpoint. Example 3.4.4 shows the SI graph for *The 103rd thing,* and compares it to that of the first section.

3.5 Conclusion

The investigation on the SI relations concludes my analysis of *The 103rd Thing*. As I noted in chapter 2, my transcription method, along with technological tools such as the *acousmographe*, would allow us to entertain other types of analysis as well, such as Roy's method, or Tüzün's method (see note 10 , chapter 1). For instance, we could note how my remarks on “fire” and on the B section in general—seen as an investigation of the hidden sounds



Example 3.4.4. SI Cartesian graph of *The 103rd Thing* (left), compared to that of Section A. The two are almost perfect retrograde of each other (Section A has a lower node and an extra one).

of the main action source—could translate well into Tüzün's ZOOMIN function, which describes a relation between sounds (his TC), and ultimately between sections (his TCS), consisting of one element being derived from a part of the previous (hence the photography borrowed zoom metaphor). However, the point of my dissertation is certainly not that exhausting all analytical possibilities, but to provide an functional method to solve the music-theoretical hindrance that concerned electroacoustic music since its inception. Indeed, the method seem to bring good resulsts for Henderson's piece as well, and in this chapter I have shown how the piece can be transcribed and apprehended, examining local components and unfolding their relation to the large-scale design. *Audible Ecosystems 3b* and *The Nature of the 103rd Thing (of 10,000)* ultimately formed a nice contrast, confirming how the method I pursued can be applied to a variety of timbral music, written in different styles and with different techniques.

In the next chapter I will conclude my research, summarizing my methodology, its benefits and its limitation, and setting the premises for future research.

Conclusion

I started my research from a simple basic premise: when we listen to any piece of music we apply the same basic conduct, namely we look for discrete elements (at either microscopic or macroscopic level) and we try to relate them. Accordingly, I proposed a way to show these elements on a score, so that they can in fact be compared and related. More specifically, in the present research I have attempted to do the following:

1. Provide a manageable method to transcribe electroacoustic music. By “manageable” I mean relatively simple and fast. The method is not specifically tied to particular styles of electroacoustic music. It is a method made for music theorists, referencing the common practice of musical notation. It consists of identifying the sounds of a piece, showing their basic morphological characteristics and tracking their evolution over time on a quasi-traditional score.
2. Show how transcriptions made according to my method can be used as a basis for analysis with some success. Different analytical strategies were applied to show the flexibility of the transcription method. Some of these strategies were original, others were borrowed from different repertoires.
3. Show that timbral music, particularly electroacoustic music, can be structurally defined and apprehended in ways that are similar those of pitch-based and rhythm-based music. Such structural characteristics may or may not be consciously present in the mind of the composer (hence the word “emerging” in the dissertation’s title).

I believe the biggest advantage of my method lies in its “in-between” status, between precision and approximation, between detail and the general view. It can show very precise information, if needed in a particular context, but it does not have to. It can show a great deal of details, or remain quite general. This is a quality that I could not identify in previous studies such as those that I mentioned in chapter 2. Also, it is intuitive enough so to allow a musician to master it quickly, without having to acquire a great knowledge of acoustics and computer-science, or psychology and psychoacoustics. In this ease-of-use and flexibility lies its greatest potential: it can be applied to pieces that, even if part of the electroacoustic realm, are stylistically very different.

On the other hand, my method is not without limitations. As we have seen, because of my intention to maintain an intuitive approach, detailed investigations on the morphology of specific sound objects, such as those carried out by Fennelly and Schaeffer (and his followers Chion and Smalley), are specifically avoided. Therefore, if one were willing to classify each sound in a piece according to indisputable parameters, and perhaps to show micro-transformations in the timbral morphology between different occurrences of the same sound, he would probably have to implement my method with additional elements (such as, for example, extended Fennellian strings). Also, my method can hardly inform how the piece was put together, so it cannot be used to inform on several compositional methods and, most of all, sound synthesis methods.

Without doubt, my ideas can be refined and implemented. Indeed, my hope is that music scholars, especially those who are not electroacoustic music composers themselves, can use this as a starting point to approach the timbral repertoire, and can develop it to produce rewarding analyses. It could also become a useful tool for students, in order to allow them to familiarize with the subject matter from the aesthesic point of view, rather than the poietic one.

In the future, it would be desirable to see comparative analyses on pieces that include both pitch-based material and timbre-based material, perhaps through the transcription (or re-transcription, in case a graphic score already existed) of the timbral material, to be superimposed to the regular notation. In particular it would be desirable to see my method applied to classical electroacoustic literature that did not yet receive successful analysis, or, in some cases, that received successful analysis that was not focused on the perceived timbral structure. Indeed, classics such as Stockhausen's *Gesang der Jünglinge,* or Varèse's *Poème électronique* have been discussed and described in detail by numerous theorists and by the composers themselves. These pieces rely heavily on modern techniques of pitch and rhythm organization, therefore we can find numerous texts that describe such techniques at great length, and in some cases even accurately list all the sounds that were used in the compositional process. The poietic dimension, in other words, is amply covered. In some cases we can even find examples of reversed engineering, were technology aided analyses seek to reveal what sounds were used to compose the piece, even if such sounds cannot be perceived by listening to the finished piece due to the heavy manipulation they underwent.[1] The perceptual dimension, however, both of the pieces as a whole and of the relation between the instrumental parts and the electronic parts, is still left to be illustrated. My method could indeed be used to fill this void, listing in a transcription all the sounds as they are perceived, rather than composed, and tracking their evolution in time and the perceptible structural relations they involve.

Finally, it would most certainly desirable to see my ideas developed by young theorists in connection to the work of young electroacoustic composers, to help bridge the actual gap between the two categories.

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[1] Park T.H., Hyman D., Leonard P., Hermans P. (2011). "Towards a Comprehensive Framework for Electro-acoustic Music Analysis," in *Proceedings of the 2011 International Computer Music Conference*, Huddersfield, England.

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