ANALYSIS AND ANALYSES OF ELECTROACOUSTIC MUSIC*

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ABSTRACT

Electroacoustic music analysis is a complex and heterogeneous discipline depending on one musical genre which includes a large typology of subgenres: from tape music to computer music, from concrete music, to mixed music, live electronic music, laptop music, etc.

Even though there are personal approaches, which causes musical analysis to be a delicate and subjective discipline, some main trends can be outlined: some analysts skip the technological dimension and base their work on perceptual dimension; other ones deepen a genetic approach. Computer science applied to sound features' extraction begins being interested to this music with promising perspectives. Any approach is worth being considered in order to create an interdisciplinary research area in electroacoustic music analysis.

In this paper, the point of view is the musicological one. The goal is to outline a general survey of different musicological and computational approaches. Each of them is partial. What musicologists and scientists now need is to cooperate and share different competences. Interdisciplinary character of future studies is fundamental.

1. INTRODUCTION

According to the musicological encyclopaedia *New Grove Dictionary of Music and Musicians*, musical analysis is the "resolution of musical structure into relatively simpler constituent elements, and the investigation of the functions of those elements within that structure" [1]. A more recent *New Grove*'s definition states that "analysis is the means of answering directly the question 'How does it work?'. Its central activity is comparison. By comparison it determines the structural elements and discovers the functions of those elements" [2]. The aim of the analysis is therefore empirical and based on the musical phenomenon itself, instead of external aspects (biographical, political, social, educational, etc.).

Since the material nature of music is difficult to define (as it is not a tangible entity), the object of the analysis must be clearly defined; it can be the score or the sound image, the mental image of the composer or its performance, etc. The definition of the limits and parameters of any analytical operation is therefore essential in order to make a useful work for the comprehension of music and in order to possibly avoid – or declare – the subjectivity of the analytical process. "The very existence of an observer – the analyst – pre-empts the possibility of total objectivity. No single method or approach reveals the truth about music above all others" [2, 528]. Any analytical method must start with the declaration of the dimension to analyse: the microstructure or the macrostructure, the medium level, the timbre, etc. [3].

Electroacoustic music analysis is still problematic because these dimensions are blurred and there is no stable compositional theory which could reflect and guide the process of listening (fulfilment or frustration of expectations [4]).

Nevertheless, a series of different analytical approaches applied to electroacoustic music starts to reach interesting results. Among musicological works, we find two main attitudes: one emphasizes a purely perceptive method based on Listening as a mean to comprehend a musical work, and justifies its view by saying that electroacoustic music is made "for listening and by listening" [5, 158]. The other approach aims at comprehending the genesis of the musical work, and investigates compositional sketches, scores, different type of technological data, etc.

Computational analysis starts to take interest in electroacoustic music and could apply its present results in automatic extracting features of sounds, classification and segmentation, for musicological analysis, its representation and transcription. Because the task of perception is complex and subjective, computer can be of great interest permitting to reach a greater objectivity through modelling.

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This work can be viewed as one attempt to organize the knowledge and competence electroacoustic music community has reached in analysing its product.

2. HOW DOES IT WORK? TYPOLOGY OF SOUNDS AND COMPOSITION IN ELECTRO-ACOUSTIC MUSIC

Electroacoustic music analytical approaches (a) can consider the sound material of one piece just as pure sound, and refer to it as sound objects which recall something existent in nature, or which have a physical identity different from other sound objects, or (b) they can base their work on the knowledge of the technological environment used to generate the sound.

In both cases, we think that the knowledge of the historical period and instruments typical of the musical repertory is fundamental, because electronic music equipment, with their potentials and limits, influence the typology of sound, the compositional process, the performance and the listening. Even if he is not interested in the real process of the technical realization of sound, the analyst should consider these aspects in order to understand at least the compositional and perceptive problems.

Each historical period has been influenced by technology and by musical context. For example, the input of Concrete Music is the recorded sound. The principle instruments of musical writing, at the time of Pierre Schaeffer, were the following: the microphone, the reverberation (initially a room or a box provided with loudspeakers and microphone), the tape and the *Phonogène*, an instrument with keyboard which permitted to vary the reading velocity of the tape (the ancestor of modern samplers). Computer and digital software now concentrate the whole process in one unique and flexible system (except for the microphone, still necessary to tap the sound). These instruments influence evidently the typology of sound transformation which can be: quotation, loop, echo-reverberation, filtering, modulation of one or more parameters, change of reading velocity of the tape (time stretching, transposition), tape reversing, spatialization [33].

On the other hand, electronic music developed in Köln in Germany at the WDR studio works from the opposite point of view, with wave and noise generators. Key-word is creating sound, not recording. Compositional approach derives from Serialism and electronic works must be analysed following this musical vision.

Computer music exploits software created for sound synthesis and its transformations. From MUSIC software to more recent programs, digital systems are nowadays very numerous and show different characteristics which influence sound, compositional practice and therefore music. Compositional techniques depend on the composer's approach and analysis is related to the precise works.

The first experiments of Mixed Music were made by E.Varèse (*Désert*, 1954) and in Köln (*Mantra* by K.Stockhausen, 1969). These works represent the two main approaches of mixed music: works for tape and instruments (the interpolation of electronic and acoustic timbre is the musical goal) or works whose acoustic sounds are modified in real time.

Acousmatic music uses recordings of everyday sounds, recordings of instruments and synthesized sounds. They are combined in their raw forms or processed, then mixed together and recorded to a fixed medium (usually CD or tape).

These are just some definitions of different subgenres of a large and heterogeneous musical world which is electroacoustic music. The most evident problem which arises from this is that a musical work, depending on the technology used, may be stored in different formats. The same music piece can be represented, for example, by a symbolic notation of the score, by a sequence of time-stamped events corresponding to pitched and un-pitched sounds, by the recording of an acoustic performance, by a series of operational or digital data corresponding to the calculation of the software for digital synthesis.

Up to now, nobody has really succeeded in considering at the very same time all this heterogeneous documentation for the analysis. We can see it from the following analytical approaches.

3. ANALYSIS BY MUSICOLOGISTS

3.1. Listening Analysis

Listening musicological analysis is based on the idea that electroacoustic music does not benefit of a unified representation code relying sonorous text with the compositional work of the composer. For this reason, the representation of the listening experience becomes the only mean to understand and study this music. Musicological literature shows individual analyses (made by musicologists or composers) or, in some rare cases, works which compare different tests of analysis.

The main, by now historical, studies we can mention are the major studies by Denis Smalley [6], Simon Emmerson [7], Michel Imberty [8], François Delalande [9], Francesco Giomi and Marco Ligabue [10].

3.1.1. Pierre Schaeffer

These studies are all inspired by the pioneer researcher Pierre Schaeffer [11], where the attention for the inner structure of sound finds its realization in the concept of sound object, *objet sonore*. The book *Traité des objets musicaux* written in 1966 is an extraordinary work of 700 pages, in which Schaeffer establishes the Concrete Music. Here Schaeffer studies the nature of the sound, which is the timbre and its form (attack, body, decay). He makes a catalogue of sounds objects (*solfège*) through five operations: typology, morphology, characterology, analysis, synthesis. Typology and morphology are complementary: morphology indicates the quality of sound (description: mass, timbre harmony, dynamics, grain, allure, melodic profile, mass profile), typology classify it (according to some criteria: mass / *facture*, duration / variation, equilibrium / originality). He finds 29 sound typologies, divided in well-balanced objects, redundant and eccentric objects. Each object is described by a table with 7 vertical morphological descriptions and 9 horizontal typology descriptions. For this reason, Schaeffer's analysis is called Typo-Morphology.

3.1.2. François Delalande

From the '70s François Delalande deepens Schaeffer's approach. He usually makes auditory tests for analysing perception of music and thinks that since listening is subjective, there is no definitive analysis. Listening conducts are actions finalized to a specific goal [12]. After testing listeners, Delalande analyzes data collected and different listening conducts, traces main listening conducts which correspond to a more objective analysis. Subjectivity reduces itself considering that each real conduct is a combination of at most 3 different listening-types: taxonomic type, emphatic type and figurative type [9].

3.1.3. Denis Smalley and Spectromorphology

Denis Smalley thinks that analysis of electroacoustic music "has to start with the perceptual *choices* of the listener-analyst who *selects* pertinent criteria. I must acknowledge that each listener, including the analyst, will make an individual, maybe unique reading of a work, but I must also acknowledge that individual readings are variations springing from shared, acculturated, human perceptions and needs" [14, 423]. He theorizes the notion of *source bounding* that is the extrinsic signification of sound material within a musical piece. He studies it through *spectro-morphology* that is the analysis of the characteristics of sound "through time – types of sounds and their shaping". Spectrum is defined by *note*, *node* and *noise*. Note can be exact, harmonic or enharmonic [13].

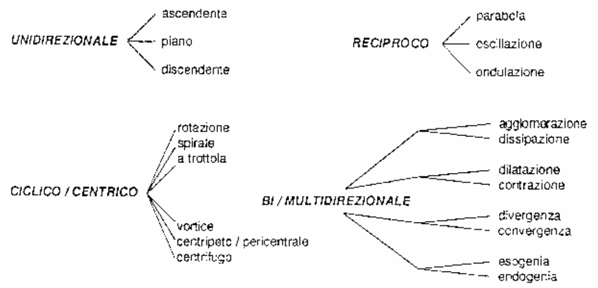

Figure 1. Movement and growth process of sound (Smalley 1996).

Spectrum realizes itself in a temporal dimension (Motion) and can have 3 archetypes: attack-impulse, attack-resolution, continuous sound. From that, one can studies all typology of movement and growth of (harmonic or enharmonic, electronic, etc.) sound [6].

3.1.4. Simon Emmerson. Sound-image-syntax

Simon Emmerson too, develops the image sound evokes by listening experience and introduces the concept of *mimesis* of natural or abstract sounds. Electroacoustic music works can be placed in a more *aural discourse* or, on the contrary, in a *mimetic discourse*, according to the abstraction of imitation. Musical form, in its turn, can be based on an *abstract syntax* or *abstracted syntax* (extrapolated syntax) [7].

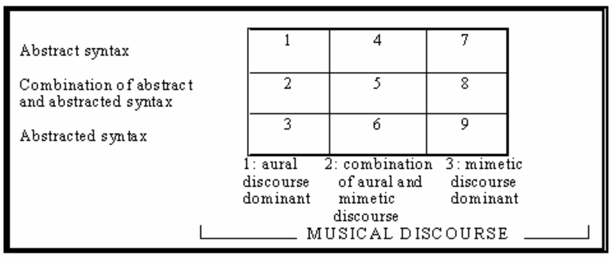

Figure 2. Simon Emmerson musical discourse's scheme.

Simon Emmerson is important for being the first composer-musicologist who published, in 1986, the first book on the problem of the language and analysis of electroacoustic music [15].

3.1.5. Stéphane Roy's recent book

In 2003 Stéphane Roy published a book devoted to Listening Analysis [16]. He focuses on acousmatic works influenced by Schaefferian theory. The book is divided in two parts:

1) the first one presents various methods applied to electroacoustic music (Schaeffer, Jean-Jacques Nattiez, Christiane Ten Hoopen, Delalande, GRM works, Henri Chiarucci, Robert Cogan, Wayne Slawson, Francesco Giomi and Marco Ligabue, John Dack, Denis Smalley and Andrew Lewis);
2) the second part shows 5 approaches which are not specifically though for this music but could be

useful. These are the paradigmatic analysis by Nicolas Ruwet, the generative analysis by Lerdahl & Jackendoff, the implicative methodology by L.B. Meyer, and Roy functional own analysis.

Roy's approach is one based on *l'analyse du niveau neutre* (abbreviated ANN – analysis of the neutral level, considering Nattiez's definition). All analyses in the second part are applications of different methods to the same piece (*Points de fuite* by Francis Dhomont), and follow a description of their context, commencing with the creation of a score identified with the neutral level. Roy identifies some sound 'unities' of the piece. Its representation is bi-dimensional and corresponds to 2 main typologies of sound (the third is a sub-genre of the second). Internal morphology of sounds can be periodic, sound-noise, complex (noise).

Figure 3. Roy's typology of sounds for the ANN (Roy 2003).

Roy's own personal approach is interesting because he shows the so-called Functional Grid with symbols of 45 functions classified in 4 main categories (orientation, stratification, process, rhetoric). The goal is to comprehend the musical unities pertinent for the ANN analysis of a musical work.

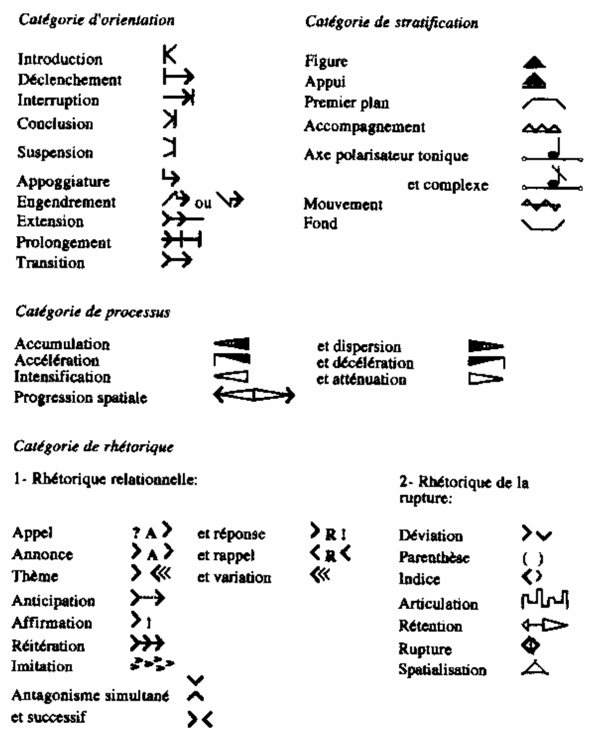

Figure 4. Stéphane Roy's Functional Grid for the Analysis at the Neutral Level.

As Leigh Landy says, an aspect that is perhaps unexpected is Roy's rejection of the sonogram or Acousmographe as a point of departure at the neutral level. Roy's reasoning is that acoustics or psychoacoustics-based research tends to base itself on the isolation of parameters. In his view, sound parameters interfere with one another too much in a complex synergy to be treated separately as far as electroacoustic music analysis is concerned.

3.1.6. Spectrograms

New images of musical sound (1984) is an important book for this discipline, where Robert Cogan and Pozzi Escot used spectrograms for analysis, as a description of the realization process rather than perceptual [17]. They were enthusiastic for sonogram capacity to represent music: "only now, through a new synthesis of scientific and musical analysis, can we begin or probe the sonic enigma. Photographs of the spectral formation of musical works provide a bridge that makes a new understanding of sound and music, sound *in* music, possible". Analyst is still important, anyway, for understanding sonogram's meaning: "spectrum photos display sonic formations vividly, but they do not quite speak for themselves (a tempting illusion). The commentaries, therefore, direct the reader's attention to those elements that are essential for an understanding of the photos".

3.1.7. Multimedia representations and electroacoustic music

Other studies aim to graphically represent the electro-acoustic music flux in multimedia contexts, starting from the musicologist's personal listening. All these works aim to describe the listening in order to understand the musical structure and/or timbre. They sometimes use acoustic representation tools (time-amplitude representations, spectrograms, sonograms). We just cite some of them, being impossible to follow all the development of this type of works.

Acousmographe is a program for the annotation of electronic music designed by the 'Groupe de Recherche Musicale' in Paris created by Pierre Schaeffer in the late 50's. This program displays the waveform and a sonogram that can be indexed and annotated by the user. The main feature is the possibility to manually add a graphical symbolic representation to represent a segment selected by the user. Recently, an algorithm that retrieves segments perceptually similar, to speed up the annotation, has also been integrated.

« Écoutes signées » is a project developed at Ircam in Paris since 2003 (www.ircam.fr/302.html) [19]. It aims at formalizing listening praxis and develops general computer tools for helping musical listening; it is thought in particular for electroacoustic music. « A 'signed listening' is a hypermedia product which aims at making a personal and original way of listening transmissible […], by suggesting types of graphic and acoustic representations and manipulations of music based on a preexisting listening practice ». The ultimate goal of the project is to develop « a generalized tool of computer-aided auditory exploration that will facilitate and deepen an *organized listening of sound* in all its diversity ». Until now, the team has presented some analysis based on mixing down some very short loops of electronic commercial music and some more general analyses which shows personal annotations of the listener (a composer).

INA-GRM is still developing the project *Portraits Polychromes*, with on-line materials and edited books devoted to avant-garde composers, their musical role and works (www.ina.fr/grm/acousmaline/polychromes/index.fr.html). Between them there are electroacoustic composers: François Bayle, Ivo Malec, Bernard Parmegiani, Gilles Racot, Jean-Claude Risset, Luc Ferrari John Chowning). Recently GRM published the interactive CD-ROM *La musique électroacoustique* [20], presenting the analysis of 6 works by composers themselves and 11 examples of qualified listeners. The CD-Rom shows different approaches from the aesthesic approach (listening) to the poietic approach (genetic).

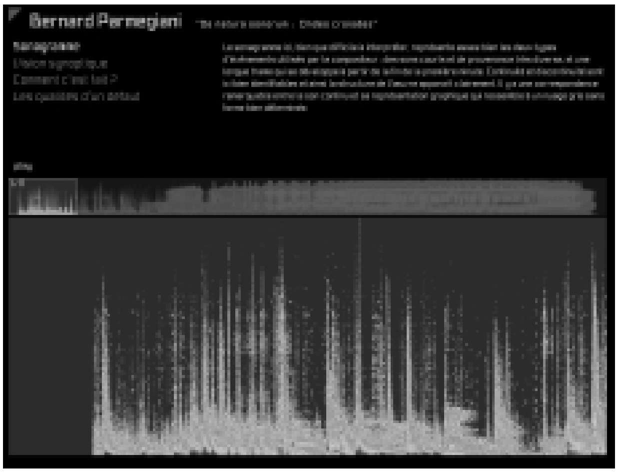

Figure 5. Incipit of Bernard Parmegiani's *De natura sonorum* [20].

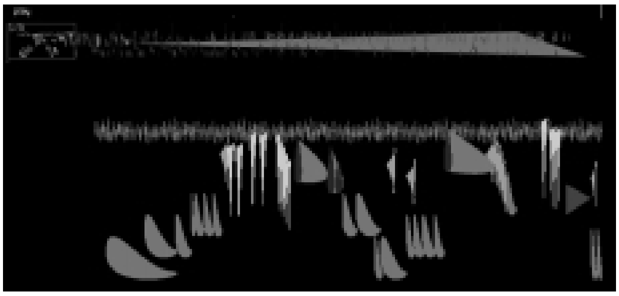

Figure 6. Bernard Parmegiani's *De natura sonorum* analysis.

The MIM (Laboratoire Musique et Informatique de Marseille) (www.labo-mim.org/ust.htm) works on the development of Temporal Semiotics Units with which it studies musical works.

3.2. Genetic analysis

This type of analysis studies the compositional process [21], or uses computer data as objective material to be analysed; one of the first studies was Lorrain's analysis of *Inharmonique* by Jean-Claude Risset [22]. These researches are still pioneering.

This approach was one of the goals of my PhD dissertation, which analyzed 6 works produced at Ircam in Paris and at CSC – Centro di Sonologia Computazionale in Padova [23] [24]. What seemed fundamental to me for the study of this music, was the recuperation of the different material used during the creation of a work: most importantly, computer scores (MUSIC software data), but also rough sketches, different recordings, published articles, etc. Reading the computer data allows an understanding, on the one hand, of the structure and the sonority of the instruments, and on the other, their temporal development within the piece. An evaluation of data lists permits the knowledge of the ways the computer was used in the compositional process. Its value can only be defined whilst taking into consideration the different tasks performed by the *P-fields* in MUSIC software: initialisation, local variables, timbre transformation, etc.

This approach is fundamental, in my vision, for analysing electroacoustic music in general, and above all mixed works. Here interpolation of electronic and acoustic sounds is the musical principle and the hybridization affect perception. The analysis of the support (tape or CD, etc.) is not sufficient to discriminate sounds, and needs the deep knowledge of the electronic technology.

4. COMPUTATIONAL ANALYSIS OF ELECTROACOUSTIC MUSIC

Computational analysis exploits the ability of a computer to analyze sounds and recognize patterns within a musical piece in a perceptually and musically meaningful manner. Up to now, significant results have been obtained for Western tonal music and for popular music.

This discipline dates back to the first researches, in the '70s, dedicated to the analysis of sound. We can cite CHANT software developed at IRCAM in Paris, Moorer's work on segmentation and analysis of sounds [35], or McAdams and Bregman researches [36].

During the '80s, important outcomes derived from physical models study, whose purpose was to obtain representations of sounds in order to completely re-synthesize them or, at least, to obtain valid synthesis from a perceptual point of view. Sound analysis aimed at not losing any acoustic characteristic of timbre.

From the ’90s, research has devoted its efforts in Music Information Retrieval studies, whose goal is to extract characteristics of sound and, to do it, to discard irrelevant aspects of it (different steps of analysis consist in pre-elaborating the sound with noise reduction, equalization, etc.; selecting frames, extracting characteristics, post-elaborating). Computational auditory scene analysis is also challenging, because modeling the human auditory system has proved to be very difficult, and promise to be a long-term interdisciplinary research.

The main problem computational analysis encounters, is the fact that electronic sounds have heterogeneous properties which are very different to regular instrumental harmonic sounds. Electronic sounds are not coded (they depend from the system), they have not a natural perceptive characteristic (except for sampled sounds) their behaviour is not regular and sometimes they rather seem (according to analytical community) to be objects to be consider in their unity rather then in their internal spectral change.

4.1. Music Information Retrieval and Electroacoustic Music

Music Information Retrieval (MIR) is an interdisciplinary research area which has grown out of the need to manage various digital collections of music and to develop rational methods for managing, preserving, accessing, researching, etc. this type of musical material [25]. The general difficulty to manage music is that it is not a simple object made by simple and low characteristic but, on the contrary, it show difficult-to-extract layers of significance, such as harmony, polyphony, and timbre. MIR works for developing techniques for extracting these high-level features. This discipline is interesting because it is a “content-based” research, to distinguish it from digital and pre-digital approaches founded on manually-produced metadata of bibliographic and related varieties. It aims at automatically extracting features concerning fine-level transcription of events and broad-level classification of pieces. The difficulty this approach encounters is the fact that, for working, it must previously know the content it is analyzing.

Stephen Downie identifies seven facets of music and notes having a significant effect on how systems can retrieve music. These are pitch, temporal, harmonic, timbral, editorial, textual, and bibliographic [26]. A large amount of literature exists on the extraction of rhythmic descriptors from musical data, from symbolic data, audio or compressed audio. Other dimensions, above all timbre, are far to be resolved.

Unfortunately, the music used in MIR studies is predominantly traditional Western music and popular music and that was the object of the overwhelming majority of papers presented in the last ISMIR conferences. Nevertheless, something is moving concerning electroacoustic music analysis.

4.1.1. An hypothetical method for acousmatic music

David Hirst presents at ISMIR some remarks applied to acousmatic music, derived from the synthesis of top-down (knowledge driven) and bottom-up (data-driven) views [34]. He develops his research starting from Gygi’s [37] and Howard and Ballas’ [38] experiments on some sonic instances of sounds played to listeners and to be classified, and on Bregman studies on timbre [39].

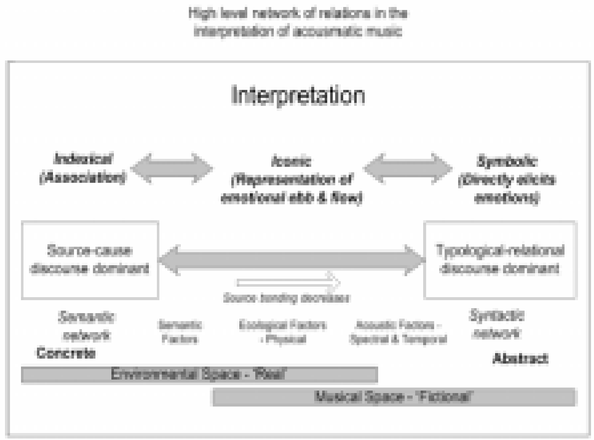

Figure 7. Hirst’s network of relations in the interpretation of acousmatic music (Hirst 2004).

Nevertheless the paper presents some theoretical consideration on a hypothetical method. Hirst tells that what remains to be completed, is to test the method on representative repertoire works. So, we can not judge the validity of this approach.

4.2. Description, segmentation, classification

4.2.1. Morphological description of sounds. Julien Ricard

Thinking over the deficiency of the MIR studies based on electroacoustic music, Julien Ricard has worked on electronic sounds, noises and sounds that have no identifiable origin, which are used a lot in contemporary music and sound post production for video or cinema [40]. He analyzes, describes and automatically classifies a corpus of separated electronic sounds, that is not within a musical fluxes. This work (developed at the Universitat Pompeu Fabra in Barcelone, Spain) was initiated in the context of the CUIDADO (http://www.ircam.fr/produits/technologies/multimedia/cuidado-e.html) on audio content description and has been carried on for the AudioClas project (www.audioclas.org) on automatic classification of sound effects. He starts from the concept of typo-morphology by Pierre Schaeffer [11]. Ricard establishes a descriptive scheme, amplifying Schaeffer’s classification, for the evaluation of the electronic sound objects. He gives each sound a numerical value or a category: subjective duration, loudness, pitch, pitchness, roughness, dynamic profile, attack, brightness, spectral fluctuation, and other (metallicness, richness, etc.). From this classification he extracts the pertinent characteristics of each sound and traces a complex scheme for the morphological description a sound objects. Some low-level descriptors automatically digitalize each characteristic of the sound.

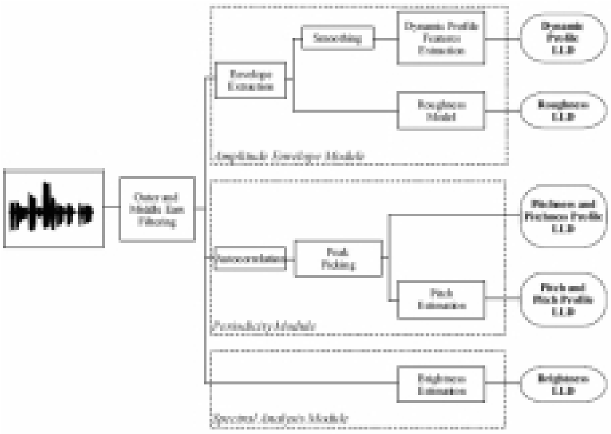

Figure 8. Block diagram of the automatic morphological description system (Ricard 2004).

This morphological descriptor has been tested on 200 musical examples. The sounds were manually labelled according to the classes defined earlier and then tested on each descriptive criterion. Classification performance is generally good, but weak with complex sounds (with simultaneous components or noise, performance of 50%). These results are still problematic. Nevertheless they are very important and promising for the study of electroacoustic music.

4.2.2. Segmentation and classification of audio files

Another experimental work has been carried out by some students in Padova University during an internal research on segmentation and classification of audio files [41]. They start from the works of Wyse and Smoliar [42] (on the categories of music, speech and 'other' based on frequency analysis), Kimber and Wilcox [43] (on speech, silence and non-speech, thought for segmenting conference's talks), and Pfeiffer [44] (analysis of amplitude, frequency and fundamental frequency of an audio file for segmenting auditory scene, including noise: shots, weeping, etc.). They analyzed an audio file prepared on purpose for the experiment, which contained a series of vowels, silence, metronome click, a fragment of song, instrumental sounds, and other letters. Using temporal windows, they calculated features (by analysing short time average energy, average zero crossing rate, short time fundamental frequency), researched rough variations, unified and damped all data. They manually classified and post-processed the data collected through a morphological and statistical analysis. This research still encounters serious problems with enharmonic sounds. Moreover, it works only with a series of separates sounds because when two sounds overlap in time and frequency, it is extremely difficult to resolve them.

4.2.3. Recent applications

Up to now, it is clear that most of the attention in this area of studies is paid to limited type of sounds, and more particularly to the design of automatic music transcription systems of traditional western tonal music. Electronic and computer sounds, noises or sounds that have no identifiable origin, can hardly be handled.

Some recent dissertations realized at Padova University (and presented during this SMC conference) addressed the analysis of computer music signals within a real piece of music. They provided some first attempts to adapt existing analytical frameworks to electro-acoustic music, in order to overcome the lack of specific objective methodologies for no traditional western music [48]. Their results are problematic but promising though. The helped in understanding the fact that audio engineering must collaborate with musicology for accelerating the comprehension of problems musicological and audio analysis has.

4.2.4. Visualisation of electroacoustic music

Good general-purpose transcribers in traditional notation do not even exist, let alone for electroacoustic music, a musical genre whose notation is very difficult. If we consider problems computational transcribers of Western music encounter, we can cite accuracy and flexibility which are not comparable to human musicians; extraction of discrete notes is still difficult; drums, percussive sounds are impossible. Some promising results are evident but just for limited-complexity music. But music *is* a complex and polyphonic sonorous phenomenon. So, if it seems that musicological (higher-level) models are necessary to further improve the transcription accuracy, on the other hand transcription is necessary for musicological analysis. Therefore, this discipline has to be improved for and from both approaches.

Anssi Klapuri, underlines this difficulty by saying that "an important fact about music transcription is that it is *difficult*. […] The problem is really not in finding fast computers but in discovering the mechanisms and principles that humans use when listening to music. […] Anyone who claims to have a quick solution to the polyphonic transcription problem, or a single mechanism that solves the problem once and for all – is mistaken. The human brain combines a large number of processing principles and heuristics. We will be searching for them for years, perhaps even decades, before arriving at, say, 95% of a skilled musician's accuracy and flexibility [46].

Anderson Mills tries to apply psychoacoustic audio analysis techniques to electroacoustic music for the purpose of visualization [32]. His goal is to create algorithms which use models of human hearing to extract audio properties from recorded electroacoustic music (based on human hearing model algorithms: Dr. Patterson's Auditory Image Model, Drs. Meddis and Hewitt's Correlogram, Dr. Ellis' Weft works, and then visualise all data in a graphical score [47].

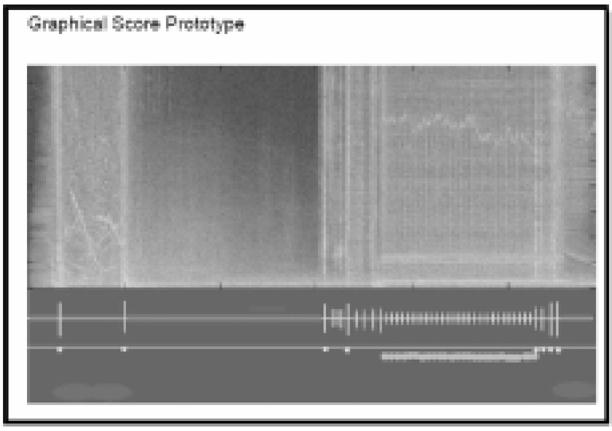

Figure 9. Anderson Mills's graphical score prototype

Mills work just shows some experiments which could be very interesting for the future research.

5. WHAT DOES MUSICOLOGY NEED?

Next year, musicological community will celebrate the 20th anniversary of the book *The language of electroacoustic music*, London, Macmillan, 1986 edited by Simon Emmerson, the first book where the problem of the analysis of electroacoustic music was clearly defined. In these years, musicologists and sound engineers have been more and more interested in this problem. However, ggiven the rapidly increasing number of electroacoustic music scholars, as well as the fact that large web-based music collections are continuing to grow in size exponentially (experimental and commercial electronic music), it is obvious that this amount of research must be organized, collected and organized in a more systematic way. Electroacoustic music community needs now to start organizing these different approaches, in order to exploiting their results for the creation of common instruments for the analysis. This is the first, very urgent, need.

It is also time to reflect on all different approaches, evaluating their merits and defects and maybe to mix them. The Listening Analysis depends on the competence of each listener; the common idea is that transcription cannot have the ambition to explain the musical object as a whole, but just to underline some aspects depending on the personal approach of the listener. However, its desire to categorize sound objects independently from their technological realization could be the right way to join a common notation of this music. This group of musicologists could help MIR researchers who have already pointed out, that MIR research programs should also agree upon evaluation measures [25]. Retrieval accuracy and system effectiveness should be measured using clearly delineated, agreed-upon methodologies and reported consistently across studies.

Electroacoustic music community devoted to analysis should reflect, before starting any analytical operation, on the following fundamental questions and concepts, which concern me closely:

1) analysis is set up on the goal it is looking for. This can be:

- the preservation of a musical heritage for permitting the re-synthesis or preserving the performance praxis, etc. (for practical reasons, e.g. obsolescence of systems, or for didactics);
- tracing graphical scores for helping the listener in the comprehension of this music;
- tracing automatic scores for helping the musicologist in the investigation of structural dimensions of the musical piece;
- automatic classification of electroacoustic music for the web search and/or for determining electroacoustic music genres, now still flowing;
- other.

2) Which are the main deficiencies and capabilities of actual research?

All actual analytical methods are partial. What I think musicologist and scientists need is to cooperate and share different competences. The musicologist is interested in comprehending the sonorous identity which is the electroacoustic music work. Its knowledge of the fragmented network of agents and processes concerned in making a piece, together with the competence of computer scientist, could bring the electroacoustic music analysis to a more clearly defined discipline.

Interdisciplinary character of future studies is fundamental. The future procedures for the analysis of electroacoustic music should be derived from the synthesis of top-down (knowledge driven) and bottom-up (data-driven) views derived from different competences.

6. REFERENCES

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