

## ANALYSIS OF THE SONORITY: AN APPROACH BASED UPON THE PERFORMANCE

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### ABSTRACT

This research proposes a methodology of analysis of the sonority in which the performance becomes a source of information, focusing on piano pieces written by Brazilian composers. For that, our methodology includes the methodology of analysis of the sonority developed by the second author of this paper [1] and englobes two main elements: the analysis of recorded data with computational support, and the approach of the Artistic Research [2]. The first element encompasses recordings of the selected pieces played by the pianist and first author of this paper, recorded in audio and MIDI and analyzed using Sonic Visualizer and Open Music. The interpretation of this information was based on the written and performative elements of the sonority in the pieces. The analysis of the data was filtered by the performer's view, which is the main idea of the Artistic Research. The application of this methodology has already provided some consistent results in the analysis of the sonority in *Ressonâncias* and *Contrastes*, by Marisa Rezende.

### 1. INTRODUCTION

Analysis and performance have been separated activities in music, and their relations were often in terms of prescription; the analysis informs the performance, and never otherwise. This research aims to propose a methodology of analysis of the sonority in which the performance becomes a source of information, focusing on piano pieces written by Brazilian composers.

This understanding is based on the acceptance that the written text is not the music, and even if it is written in a very specific way, it cannot encapsulate all musical features and the interpretative decisions [3]. The starting point of our methodology is our own model for an analysis of the music based on its sonorities [1] and it includes two main elements: the analysis of recorded data with computational support and the approach of the artistic research [2].

This paper is part of a major doctoral research, in development at the Federal University of the State of Paraíba (UFPB), Brazil. The goal of this doctoral research is to develop a methodology of musical analysis, more specifi-

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cally for the analysis of the sonority in piano pieces along with the musical elements given by the score.

In this paper we aim to present an experimental method for the analysis of sonority that was applied in two piano pieces: *Ressonâncias* (1983) and *Contrastes* (2001), by the Brazilian composer Marisa Rezende (1944). These pieces were selected because of the importance of the sonority in their construction, both in the performance and in the compositional project.

### 2. THE MORPHOLOGICAL UNDERSTANDING OF THE MUSICAL WORK

The construction of the sonority in this research is understood as the result of the interaction between performer and text (score). This understanding is supported by the idea of music as performance [3]. When the musical text is understood as something that can represent the entire musical meaning, many musical aspects, such as the performative ones, are missed. The performer, with his or her own subjectivity, musical view, background, and personal musical decisions took upon the score, contributes as an active subject to the construction of musical meaning. There is no score capable to encapsulate all the nuances and possibilities that a musical score proposes. The methodological possibility that will be presented has an experimental nature, once the musical source of meaning is no longer the written text, but the performance, through which the score has already been interpreted and filtrated by the performative view and transformed into real sound.

One of our main theoretical references for this research is the theory that defines the morphology of the musical work [3]. This theory proposes a shift from the ontological to the morphological concept of music. The morphological question verses on the perceptual aspect of music and on the transformations suffered from performance to performance and how these transformations occur. In other words, we shift from an investigation of the musical work as an ideal represented by the score to the investigation of it as music in act, and as performance. This emphasis on the process allows a more flexible attitude towards the musical notation, which no longer defines a fixed musical object, but fixes the conditions of performance to achieve a specific sonorous result.

### 3. ARTISTIC RESEARCH

The Artistic Research [2] is a kind of understanding that switches the research focus to the performer's view and, most commonly, in one specific performance. The justification for this kind of research encapsulates both the possibility of the inclusion of a deeper knowledge about the musical practice and the idea that one specific performance of a piece brings in itself important elements about the work as a whole.

Since the beginning of the establishment of the research in music as a scientific knowledge in the early XX Century until little time ago, performance was always subjugated as a field of research. For a long time the phenomena related to the performance were always analyzed through the perspective of other fields, as Musicology, Psychology, Musical Analysis, etc. However, only recently the performer himself was invited to contribute as a researcher, and not as an object of study, in researches regarding the performative processes. Despite being the creator of the music as sound, the voice of the performer has been muted for a long time.

As a natural consequence of the process that is happening nowadays in the contemporary Musicology, the detachment of the understanding of music as score and an approximation to the understanding of music as process/action, the performer sees himself brought to the center of the debate. This change allowed the development of new methodologies of research, such as the Artistic Research, which is gaining emphasis in the academic production in the field of performance in the last decades.

In this kind of research, the performer acts as a researcher, in the traditional sense of the word, without losing his role as an artist. At the same time that he observes, he is observed by himself, in a way that "the artist investigates his own practices, materials and fonts" [2]. This means that a double role is attributed to the same individual, to generate an auto-reflexive process that is not-transferable and personal. This very notion of the Artistic Research is something that defies our culture, which is habituated to establish the research through results that can be confidently transferred to other contexts [2]. However, it is the only possibility to truly understand truly the artistic and creative processes and to allow an approach totally focused on the process. In this way, the Artistic Research involves a de-territorialization of the research culture in arts, "which is nowadays still dominated by scientific and epistemic approaches" [2].

The main goal of the proposed analysis is to add the interaction between score and performer as a prime source of musical meaning, as something that will, in fact, determine musical structures. Researches where these non-textual elements are included often use adapted theoretical background from other areas (such as Linguistics). Our goal is to propose a methodology of analysis totally developed regarding the musical phenomena.

### 4. A METHODOLOGICAL PROPOSITION

The analysis of the selected pieces is focused on one specific performance, the one made by the pianist and first author of this paper. The interpretation of the pieces prioritized mainly the manipulation of sonority, bringing up aspects of piano timbre that can be manipulated by the performer. As methodological support, this analysis used records of the piece in public performances and in private study sessions and also a study diary. This diary brought information about the development of the piece, since the first reading of the score until the moment of its public performances. The sonority was analyzed through the recordings made during the learning and performing phases. In a first moment, the performative decisions served to separate the piece into sonority units. Done this identification, the main aspect of the sonority in each one of these units was analyzed by adopting our method for the analysis of sonority [1].

To start the reflections about the sonority in the piano, we brought the table below [4], to better understand which are in fact the elements available for the performer interference in terms of sonority. We have, in the first column, a list of the constitutive elements of timbre and, on the right, the level of control that the performer has in these elements, and how this control is possible.

Constitutive elements of timbre	Level of control
Number of strings put in vibration	Medium ( <i>una corda</i> pedal, with no effect in grave)
Enarmony (of string, affination)	Null
Number of partials	Null
Number of partials produced in the audible area	High – velocity of attack, pedals
Relations of frequency between the partials	Very low, UC pedal in some cases
Location of partials in relation to the sensible zone of the ear	Null
Relative level (dB) of partials (in the same intensity)	Null
Partial's level of acoustic pressure	High, velocity of attack
Order and velocity of the emergence of partials	Medium, velocity of attack, articulation

Order and velocity of the extinction of partials	Relatively high (except at the upper register) relaxation in touch and/or sustain pedal
Relation noise (of mechanism)/ sound	Very low, kind of attack
Reverberance, resonance	High, through pedals and specific touches
Velocity of hammer	High, velocity of attack
Movement of hammer	Low, kind of attack, velocity of attack
Duration and local of hammer contact with the string	Null
Action of dampers	High, relaxation of touch, sustain pedal
Harmonic table	Null

Based upon this table, it is possible to affirm that the performer has some important tools available to manipulate the piano timbre, and this manipulation will be the result of his or her interpretative decisions. With this knowledge and the practical contact with the pieces, some considerations about the sonorous structure of the piece were made. From the point of view of performative decisions, we can state that questions as the use of the sustain and *una corda* pedals, as well as the articulation (comprehended as the choices of pianistic touch), will be important elements for the analysis, because they are decisions of the performer that will directly affect the sonority of the piece and, consequently, its morphology. These sonic characteristics are understood as the variant elements of the piece, that might change from performer to performer, but that are important elements of the sonic constitution of the piece.

Also crucial is the identification of the invariant elements, the ones secured by the score, that will remain the same from performance to performance. In the case of the pieces analyzed, the register appeared as the most important element of stability in the written aspect of the sonority.

It is important to reinforce that, in this analysis, both the division into sonority units and the identification of the main aspect of the sonority in each unit will be done based on the practical relation with the piece, taking into account this relation as a performer, not only as an analyst.

## 5. METHODOLOGICAL PROCEDURE

The first element of our methodological procedure encompasses the recordings of the selected pieces in audio and MIDI. These recordings were made with piano Yamaha Clavinova CVP-701 and played by the pianist and first author of this paper. The MIDI data were generated by the piano and the AUDIO data was recorded using a camera SONY HDR-MV1, both recordings done concomitantly.

The data obtained in these recordings were analyzed using the software Sonic Visualizer and Open Music. The interpretation of this information was based upon the written elements of the sonority and also on the performative elements of the sonority, such as the use of the pedals and the choices of pianistic touch. The analysis of the data was filtered by the performer's auto-reflection about the piece's interpretation.

Through the data from the MIDI files, we extracted information about Velocity and Sonic Basic Quality (more about below), while from the AUDIO files, we extracted information about spectral centroid and spectrograms.

This procedure of analysis is oriented by the concept of *Compound Sonic Unit* and its relative complexity. A Compound Sonic Unit is a synthesis, at a given point of the piece's timeline, of a certain number of secondary components that interact in complementarity (e.g. density, harmonicity, periodicity, entropy, a.o.) and whose *relative complexity* can help to build a representation of the dynamic curve of the sonorities of a work. Each component is weighted onto a simple-to-complex vector according to its inner configurations or behavior, so that a more complex configuration is expected to render a relatively more complex Sonic Unit.

It is also relevant to reinforce that the sonic units were detected in these analysis departs from the experiential contact with the piece, with a performer's positioning. This means that the interpretative choices regarding variations in dynamics, timbre, pianistic touch, pedals and timing are the main elements that shape these sonic units. In these analyses the sonic units are determining the piece's contour in homogeneous sonority sections. Each different section has specific sonorous characteristics and each change of section is linked to changes in these characteristics, which in these pieces essentially takes into account elements as: use of the pedals, register and pianistic touch.

The MIDI files allowed us to extract and analyze two main elements: velocity (V) and the sonic basic quality (Q). For this task, we used the *SonicObjectAnalysisLibrary*, an Open Music library dedicated to music analysis<sup>1</sup> [5]. We first used the SOAL function *velocity-per-onset*, which read the file and returned the MIDI velocity values (from 0 to 127) for each note played at each onset (e.g. at

<sup>1</sup> This library is developed by the research group MUS3 (NICS/UNICAMP).

each attacked note(s)), to interpret diachronically the evolution of the pianistic touch.

The other element, the Q function in the library, needed to collect three sets of data: (1) the register (related to the localization of notes into the piano gamut, obtained from the analysis of MIDI notes), (2) the relative intensity of the played notes (calling again the MIDI velocities data), and (3) the use of the pedals, including the sustain pedal and *una corda*, and every combinations between the two pedals, including the use of half pedals [5]. The model for the calculation of the Q value of a given piano note is based upon the principle of a general (but nonlinear) decline of the timbric complexity of each pitch in proportion to its fundamental frequency – the higher the fundamental, the less complex its timbric structure [5]. The three reasons for this decline are: (1) the decrease of the number of audible partials for a given fundamental, (2) the decrease of the position in the spectrum of the stronger partial/s, and (3) the decrease of the duration of the sound's extinction phase [4]. This idiomatic decline is more or less modulated by the second (velocities) and third (pedals) components. In this way, while V brings specific information about the performer's approach in the instrument, revealing the exact impact of each note played (what will affect both the dynamics and the timbre in the piano), Q brings a synthesis between a static data (pitches) and a dynamic data (interpretative decisions, represented by velocities and pedals) and generates a value that represents the resonance.

In complementation to the MIDI data, we also analyzed the AUDIO files of the works, in order to evaluate the impact of the interpretative decisions onto the resulting sound of the pieces. For this task, we used Sonic Visualizer, a software that allows the visualization of different aspects of the sonic signal [6]. At this point we used specifically two tools for analysis: the spectrogram and the spectral centroid. The visualization of these two representations of the sound can reveal important information about it. The spectrogram shows data such as the number of harmonics produced for each played note, the localization and duration of these, whereas the spectral centroid shows specific information about the localization of the center of the mass of the spectrum. The spectral centroid can also show us information about the brightness of the sound: a sound with darker quality tends to present more prominent content of low frequency, while a sound with a brighter quality tends to present more predominance of superior harmonics, which can be measured by the spectral centroid [7].

This methodological procedure generated graphs and visual images of the selected parameters, which will be shown in the oral presentation, and that are available for consultation in an already published article where a complete analysis is presented in detail [8]. The results obtained showed the relevance of the performative interferences (interpretative decisions) in the construction of the sonority of the pieces.

The data obtained by V (MIDI velocities) showed how the instrumental approach happened in a real way, con-

firmed that the interpretative plan was effectively accomplished regarding that the choices of touch (a touch with faster velocity *versus* a touch with a lower velocity) was concretized. The Q value, on the other hand, revealed the dynamic balance between the three elements included in the calculation, varying the preponderance of one onto the others and showing how the interpretative decisions occurred at the same time as some changes in the sonority in the written aspect (mainly in the register), letting us comprehend how these different elements derived from the score and from the performance acted side by side to create the timbric characteristics of the piece.

On the other hand, the parameters extracted from Sonic Visualizer confirm the correspondence between the interpretative decisions and the audio output of the recorded performances. All the previewed changes in the sonority from a brighter to a darker sound could be seen clearly in the images of the spectral centroid. Also, the sections with the higher Q values corresponded with the time point of the spectrogram, which gets the higher intensity and quantity of audible harmonics.

To conclude, we could confirm that the use of the pedals and the choice for the pianistic touches, in combination with the most relevant written elements of the sonority, dynamics and register, contributes to create the whole sonority of the pieces.

## 6. CONCLUSIONS

The methodological procedure presented in this paper serves as an opening to the insertion of the performance in the context of musical analysis, where the musical text and the performance act side by side in the creation of meaning in the piece, and also make it possible its existence as a sonic object. Without the score the performance of these pieces would not exist, but, on the other hand, without the performance the piece would not exist as a real happening and neither would be any sonority to be analyzed. Therefore, the collaboration between composer and performer shows itself as a manifested factor in a non-intentional way (that is independent of the intentionality of this collaboration) and inherent to the existence of the musical work.

In this analysis the conceptual basis of the morphological understanding of the musical work and the methods of the Artistic Research actuated as a bridge between theory and practice and already provided some interesting results [8], which open way for future developments.

Finally, the analyzes highlight the crucial role of the performer in the analytical process, as someone capable to add relevant information about the piece, information that are only and exclusively obtainable through the experiential contact with it. Thus, the significance of the performer's voice in the development of musical knowledge makes itself recognized and manifested.

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