# Toward a Listening Based Taxonomy for Live Electronic Processing of Sound. Case study: Works produced at LIEM

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## Abstract

This paper is part of a bigger project, which has the goal to find a taxonomy for live sound processing, intended to be applied from the listener viewpoint and independent of technology implementation. Trying to classify various types of sound processing from a musical viewpoint could be useful for music analysis and for understanding the real contribution of live sound processing to the music. A useful classification needs the definition of relevant criteria that could be applied to any type or work and to the listener experience. As a first prototype, we have applied and tested several criteria on the analysis of 25 musical works by Spanish composers produced at the LIEM environment. These criteria included among other: 1) processing severity or the relation degree between original and processed sound, 2) time behaviour such as static, dynamic and modulating, 3) general relationship with live instruments, 4) perceptual attribute that is processed, clustered around duration, pitch, timbre and texture, and 5) relationship with space. The collected data have shown several global features on the studied repertoire, which can lead to conclusions about composer preferences and trends. In this particular set of works we see that the most used type of live sound processing is that of placing the live source in a virtual space, followed at some distance by timbre transformation.

## Introduction

This paper is part of a bigger project, which has the goal to find a taxonomy for live electronic processing of sound, intended to be applied from the listener viewpoint and independent of technology implementation. My motivation is that as a composer I am very interested in the topic but I need more coherence in order to integrate live processing as an essential part of my music and not as a decorative effect.

Live electronic processing of sound in a concert situation has a long tradition, with precedents such as *Imaginary Landscapes* (Cage) from 1930s, but it started definitively in the 1960s with *Microphonie I* (Stockhausen) and other pioneer works. The study of this practice is close related to mixed electroacoustic music and to live electronics.

In the 1980s the spread of MIDI protocol introduced a new type of processing called “event processing” (Emmerson, 1991), in which music is represented by a stream of events that

could be manipulated in many different ways. This allowed the introduction of live interactive composition in which a computer program is reacting to the outputs of musicians and generates music live. The previous sound (or signal) processing evolved using dedicated hardware, at the beginning in the analogue domain and later in the digital one. Afterwards, the increase of power of personal computers allowed the use of programming languages specialized on live processing of sound, like Max, PD or SuperCollider. Today, both signal and event processing tend to merge in a hybrid set of practices.

The evolution of technology has been very rapid and has generated some problems. Just to name three of them: 1) Technology obsolescence: When pieces get older many composers renounce live processing and prepare new versions with recorded electronics. 2) Some lack of musical thinking: The complexity of technological details sometimes obscures descriptions of sound processing from a music functional viewpoint. 3) The peculiarity of live electroacoustic music performer: There is no a standard profession compared to pianist or sound technician. Composers in many cases are the performers or improvisers on their own works, leaving little documentation.

## First attempts of classification and testing on works produced at LIEM

The evolution of technology at LIEM[1]: From the opening on 1989 until 2012, the LIEM has been involved in the production of more than 600 hundred works. In this paper we focus in a set of 25 works either composed there, or produced at LIEM concerts. All of them use live electronic processing of sound and belong to Spanish composers. The technology in this lab has been based mainly on commercially available equipment, starting with dedicated sound processors, manually or computer controlled via MIDI, to evolve, at the end of the 90s, to use computer applications developed in Max or PD.

Why this classification?: Trying to classify different types of sound processing from a musical viewpoint is useful for music analysis and for understanding the real contribution of live processing of sound to the music. A useful classification needs the definition of significant criteria that could be applied to any type or work and to the listener experience. As a first prototype, we applied to the proposed set of works five criteria: Processing severity, time behaviour, relationship between live acoustic sound and electronic result, perceptual attribute that is processed, and relationship with space.

## Processing severity

This criterion refers to the resemblance degree between acoustic original signal and live electronic result. Alain Savouret (2002) says that if there is any relationship he calls it "transformation" and if there isn't "transmutation". In the considered set of works only one of them used processing in this last category; this peculiarity makes sense, since the presence of live acoustic instruments is usually strong and composers rather leave transmutation for the recorded electronics ("the fixed part").

[1] Laboratorio de Informática y Electrónica Musical, from "Ministerio de Educación, Cultura y Deporte", in Madrid, Spain.

## Time behaviour

It inspects whether the sound processing is static, dynamic or modulating. Static, in the case the processing does not change on time; dynamic, if there is change in some direction and modulating if it fluctuates following a periodic or non-periodic function. In our set of works we observed no preference among these.

## Relationship between live acoustic original sound and electronic result

According to Vandenbogaerde (1972) there are four types of such relationships: "division", "dialogue", "fusion" and "extension". "Division" is when there is not a clear relationship between original acoustic part and processed one; none of the studied works showed this type. In the "dialogue" one, there is a question-answer relationship, 36% of the considered works had preference for this one. "Fusion" is when both worlds merge to create a new sound, this applied to 4% of works. And "extension", when the processing is used to enhance or heighten the acoustic sound, this one is the most used type, on 60% of works (see fig.1). This leads us to the conclusion that most of the considered works use live sound processing rather as orchestration or instrumentation effect.

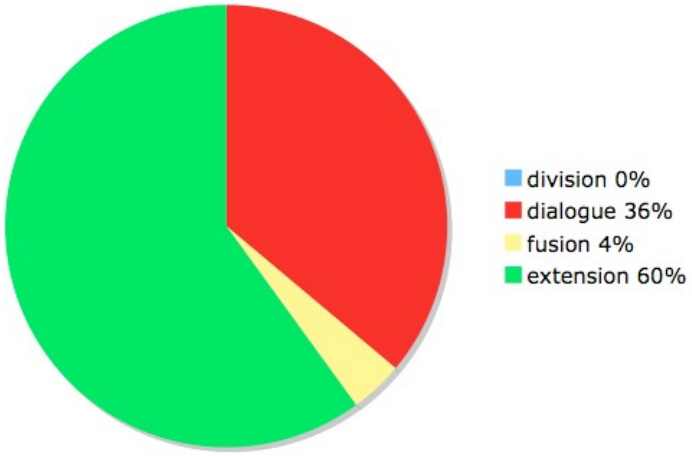


**Figure 1:** Percentage of works in the considered set in which predomine each type of relationship between original acoustic sound and processed result

## Perceptual attribute that is processed

We considered the attributes of duration/time, pitch, timbre and texture (Verfaille, 2011, p. 15). Processing duration or time, like in time inversion, time scaling (expansion or compression), shuffling, delay, etc. was used in 36% of works. Pitch processing, like pitch change, pitch shift or harmonizing, was found in 44% of works. Timbre processing on 64%. And finally texture processing such as proliferation, granulation, modulation, etc. was found in 28% of works (see Figure 2).

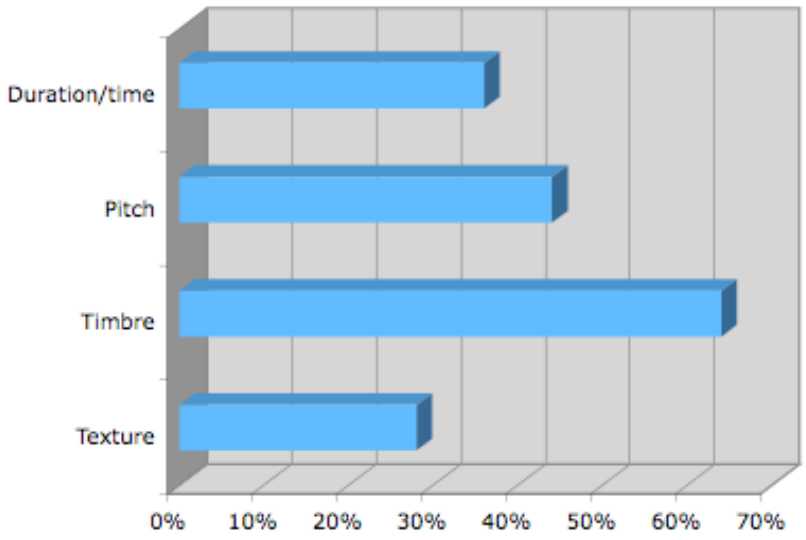


**Figure 2:** Percentage of works in the considered set in which predomine processing of these perceptual attributes

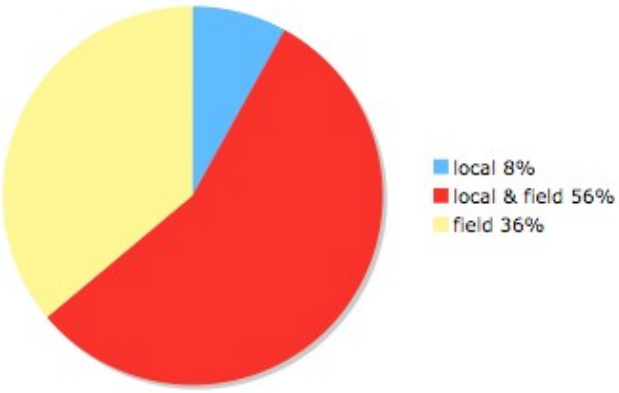


**Figure 3**: Works distribution from the considered set in relationship to space processing

## Relationship with space

Simon Emmerson (1997) proposed the ideas of "local" and "field" in live electronics: The processing which "seeks to extend the perceived relation of human performer action to sound production" (for instance the processing of timbre) would be "local", and when the sound is placed on a virtual space using reverberation, echo, panning, etc., it would be "field". An overwhelming 92% from the studied works use this last type of processing, and 56% of them combine it with local processing, leaving a 36% of works that only process space (see Figure 3).

This attachment to space is usual in live electroacoustic music, but even more in this set of pieces, which were influenced by the availability of Quadrapan, a spacialization system developed at LIEM by Céster, Arias and Pérez (Perez Garcia, 1996) (see Figure 4).

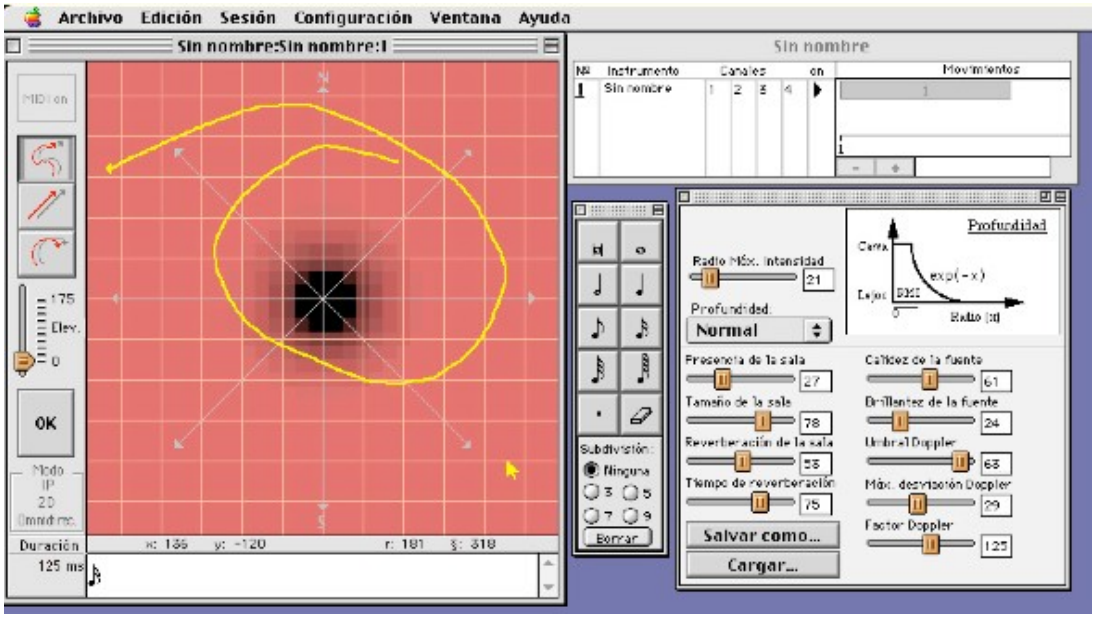


**Figure 4:** Quadrapan by Isidoro Pérez and Javier Arias

## Other criteria (not considered in this paper)

Other criteria could have been applied which are more specific to describe what is perceived when listening live processed musical sound.

In timbre processing we can detail three main different types: 1) Spectral envelope modification (change the amplitude of components) like in equalization, filtering or distortion. 2) Spectral components modification (change the frequency of components) like in inharmonizer, ring modulator, etc. 3) Dynamic envelope modification.

In spatial processing we can identify whether the work is using room simulation (reverb, early reflections, etc.) or localization of virtual sound by means of distance, height and azimuth angles, and doppler.

From a musical analysis view we could concentrate on how the processing affects the original sound, for instance see whether it is like a variation of original, an ornament, or whether its roll is structrual in the piece. Or whether the processing affects the form or the syntax of the piece. Instrumental music theory can provide many tools to be used here, and it could be complemented by theories originated from the acousmatic music like Typo-morphology and Spectro-morphology, as we see next.

Another diverse approach would be to use Schaeffer's (and further developments) Typo-morphology (1988). It would be useful to segment the musical sound signal and classify the extracted sound objects, then identify what is different and what change between original sound and processed one, how the typo-morphology of a each sound object is changed. The Spectro-morphology (Smalley, 1986) is another approach that could be applied to describe how sound is changed by processing.

## Musical examples

To illustrate some of the processing types referred in this paper we can listen several passages taken from the following works[2]: 1) Modulating processing in *Magma* (piano and electronics) by Consuelo Díez. 2) Processing of time in *Veo una voz* (voice and electr.) by Francisco Martínez Cabeza. 3) Pitch and timbre processing in *Utopía A* (piano and electr.) by Adolfo Núñez. 4) Texture processing in *Los Misterios Mitra* (flute and electr.) by Gregorio Jiménez. 5) Space processing in *Secuencia* (voice and electr.) by Alina Blonska. 6) Syntactic processing in *Concierto para sonido* (chamber ensemble and electr.) by Adolfo Núñez.

## Conclusions

Finding an appropriate taxonomy for live sound processing can help to characterize, classify and analyze a repertory of works. We have tested several criteria on a set of works by Spanish composers. Collecting statistical data based on those criteria has shed light on composition practice tendencies, and at the same time could show whether the criteria are useful or not.

Statistics results in this set of works show that the most used type of live sound processing is that of placing the source in a virtual space (92%), followed by timbre transformation (64%). I think these preferences make sense and are coherent with western music evolution. First of all, space dimension in music and playing with the space, has always fascinated musicians, and electroacoustic media has allowed implementing these interactions very easily. On the other hand, live electronic timbre transformation is a variation of extended instrumental practices, a very common tendency that started on 20th century inside the steady search for new sounds.

In the near future we expect to add new criteria and test them in a wider and representative set of works chosen from the whole span both historical (from the 60's) and geographical. Our distant goals would be to better understand the importance of live electronic processing of sound in the music of last decades, and to find the specific features which differentiate, from listening, the music with live processing of sound from the music elaborated at studio.

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[2] Sound examples can be obtained from the author.

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