The Electric Guitar: Forms of Augmentation and their use in the Contemporary Repertoire.

Daniel Santos 1**, Henrique Portovedo** 2, 3

1 Technical University of Madrid, Spain

info@danisantos.es

2 Citar – Portuguese Catholic University, Portugal
3 University of Aveiro, Portugal

henriqueportovedo@ua.pt

Abstract

This article describes the invention's processes of the electric guitar and of augmentation progress. The research pays attention to the context where it came up and link this invention with current concepts from social Sciences and Philosophy that clarify its origin and organological trajectory. In the second section, the article makes a comparative analysis of several composition works for augmented electric guitar in order to better understand the use of augmentation on the instrument. From the observations obtained comparing these case studies, the advances of the instrument in recent History are understood as an evolution towards electronic flexibility and performative playability, volume control and integrated computers. Finally, some aspects of the instrument augmentation process are described, these aspects are related to musical performance and its influence on the development of performative skills.

I

The Electric Guitar was developed in the decade of 1930s and can be considered a forerunner of the growth of augmented instruments. Its invention was motivated by the volume amplification requirements of the classical guitar in musical ensembles and its existence is the result of a collective and social process of adaptation of the instrument to the needs of the time. Its first developers were Beauchamp and Rickenbacker, who applied the technology of electromagnetic amplification to instruments (RIC, 2021). Later, in the decade of 1940s, there were significant advances coming from Leo Fender and Les Paul, who design the solid body of the guitar. Les Paul also turned the instrument popular with his performances on clubs, radio and television and developed fundamental technology of music recording (Les Paul Foundation, 2016).[1]

From its beginnings, the evolution of the instrument was a collaboration between art and science, especially close between the fields of performing and sound engineering.

[1] Les Paul (…) can also lay claim to having invented multitrack recording. Multitracking involves recording a performance and then rewinding the take to the beginning in order to add more music to it. (Byrne, 2012).

However, this success was also due to its use by jazz, pop and rock musicians. The idea of social adaptation and collaboration between interdisciplinary areas is, therefore, at the origin of the electric guitar and can be seen as related to latter concepts, such as *assemblage*, introduced by Gilles Deleuze, or *ubimus* (Ubiquitous music, an implementation in the music field of the Ubiquitous computing idea of Mark Weiser). Extracts from original articles related to both aspects are the following:

> (…) an emergent field of research that combines several areas from sound and music computing, human computer interfaces, creativity studies, music education, with a strong social and community underpinning (Keller et al., 2019).

> The concept of assemblage encompasses this reformulation of criteria, considering not only the instrumental technical characteristics, but also the performative practices themselves from a sociocultural perspective, reflecting the identity inherent in contemporary times as the incorporation of different processes and the reconfiguration of concepts and practices (Portovedo, 2020).

As a result of technological improvements dictated by performance needs, the electric guitar became an instrument constituted by electromagnetic amplification and integrated microphones.

> The three types of electric guitar (…) all use steel strings and magnetic pickups. (…) The pickups "listen" to the string tone's acoustical characteristics, which are determined by the quality and design of the guitar top (Schneider, 1985).

There was a shift in the conception of sound in comparison to the classical instruments. In the electric guitar what produces sound, loses importance compared to what reproduces it. In other words, although there is still a very important physical and instrumental component (the body of the guitar), the sound is being defined by the amplifier and the effects.

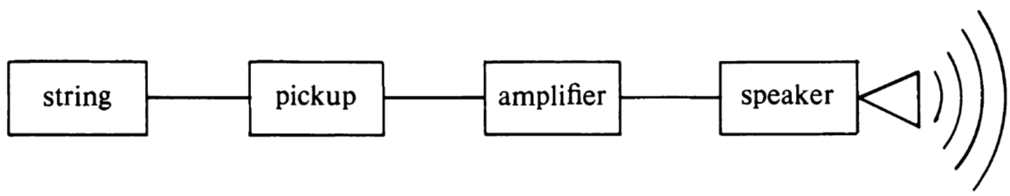


Figure 1. Electric guitar scheme (Schneider, 1985).

The introduction of various elements into a sound chain is the first attribute that makes it an augmented instrument, considering that an augmented instrument is currently defined as:

> A network of sound production and processing units, spatially extended and configurable by the player according to the desired sonic results. (…) The initial sound source (the acoustic guitar) becomes a part of an electro-acoustic chain (Lähdeoja and Navarret, 2010).

Therefore, the augmented instrument has a series of new features. In Augmented Instruments, the artistic intentionality around the result of the sound takes on a fundamental role. The acoustic aspect is of minor importance, and the musician could integrate the sound into an analogical sound chain or convert the signal into a digital signal. Finally, it is possible to split the guitar signal and use both digital and analogical at the same time. The fundamental point is that there is neither an ideal sound, nor a standard and the potentialities are multiple.

Performative control on the playability is also a critical aspect in the development of an Augmented Instrument. From the external control of the sound parameters, progress has been made to integrate hardware control embedded into the instrument (potentiometers, timbral controls, digital controls), passing through an external hardware control in the setup (pedals effects) to reach a control that also includes an item of computer + software.

Finally, this "sound network" requires the knowledge on the systems that make up the augmentation as a fundamental subject for performers and composers. In addition, relationships with objects, not only have an internal sense towards the understanding of the electronic configuration and signal processing, but also act in an external sense, towards the objects that promote indirect action on the instrument. (e-bow, bottleneck, whammy bar etc.). This kind of external action over the sound network has a close relationship with current studies in the musical gesture, because the indirect gesture become a complementary excitation of the internal process.

> Furthermore, a sound-producing gesture can be defined as an excitatory action, i.e., an action of setting some object (e.g., parts of an instrument) into motion by hitting, stroking, or bowing. Excitation gesture are either *direct* or *indirect*, depending on whether or not there is an object between the sound-producing element of the instrument and the object carrying out the excitation. For example, the actions of playing the harp or congas are direct since fingers and hands are directly in control of the resonating objects (strings and drum membrane). But there are also many indirect instrumental actions that involve one or more objects in the interaction, for example the bow in string instruments, the key mechanism on the piano, or sticks for drums. (Jansenius et al., 2009).

Nowadays, all the referred progress in the process of augmentation is applied to the composition for electric guitar. However, even though these features broaden the horizons of the electric guitar as an Augmented Instrument, they also create a problem when it comes to assimilating the possibilities. In fact, there is enormous flexibility in the systems:

> Currently, the electric guitar appears as a user-configurable, hybrid and modular instrument. It is comprised of acoustic, electromechanical and digital parts, all of which are integrated into an instrumental environment. (...) The instrumental environment offers a high degree of configurability for the musician (...) As a result, a wide variety of diverse objects coexist under the common name "the electric guitar" (Lähdeoja and Navarret, 2010).

Difficulties in expressing written music may also arise:

> If, on the one hand, the maturity of a particular musical aesthetic also translates into the standardization of notational elements, on the other hand,

> the exploration of sound fields increases the difficulty of stabilizing a symbolic language, residing here one of the greatest difficulties inherent to performance and to study of new music (Portovedo, 2020).

These difficulties can drift into a practice not equated with theoretical development with learning difficulties, atomized practice, economic gaps and failures in live systems. This reflection leads to the proposal of organizing setups that homogenize the practice of electronics in contemporary music and to the question of what the skills of the performers should be when working with augmented instruments. The importance of performing the works on stage is central to be able to continue with the development of the new contemporary trends, thus obtaining the feedback of the action / perception.

> This leads us to valorize what is perhaps the most important issue for an ontology of music: the fact that situations organized around the production of music would not be pertinent if they were devoid of implications touching directly on questions of action and perception. (…) Action and perception lie at the heart of musical processes, as these musical processes are created by successive operations of concretization having as a tuning tool—as a principle of reality— an action/perception feedback loop (Vaggione, 2001).

Some of the approaches and works that have been developed for the instrument are shown below, through the analysis of five case studies for the electric guitar written from the late 1980s of the 20th century to present. They represent a sample of how the instrument and its sonic possibilities have been thought out. Through the process of "action/perception feedback loop" derived from the performance the needs and possibilities of the instrument are revealed. Frequently, essay and error process through the performance show how some technical issues could be solved and how some aesthetic results could be achieved. Finally, we present some technical and aesthetic directions of the instrument envisioning future directions.

II

The case studies analysed are the following: *Vampyr!* (Tristan Murail, 1984), *Electric Counterpoint* (Steve Reich, 1987), *Trash TV Trance* (Fausto Romitelli, 2002), *Momentum Anomaly* (Elliott Sharp, 2006) and *Not I* (Stefan Prins, 2007).

Tristan Murail's work *Vampyr!* (1984) absorbs many elements of Hard Rock and Heavy Metal music:

> The desired sound is rather that of the solo guitar as played by Carlos Santana, Eric Clapton etc. (…) The player should put into Vampyr! All the energy of rock music and that includes the appropriate number of decibels! (Murail, 1984).

The work formalizes certain elements of writing for the electric guitar, such as the directions of the pick and the use of the whammy bar. Despite being the simplest setup of the works analysed, in the performance it is important to be able to modulate the distortion parameters and operate on the amplifier in real time (Figure 1) for which some type of pedal effect is needed to organically control the amount of distortion used at any given time. This use of the pedal effects can be seen in the performance of Flavio Virzi (2011).

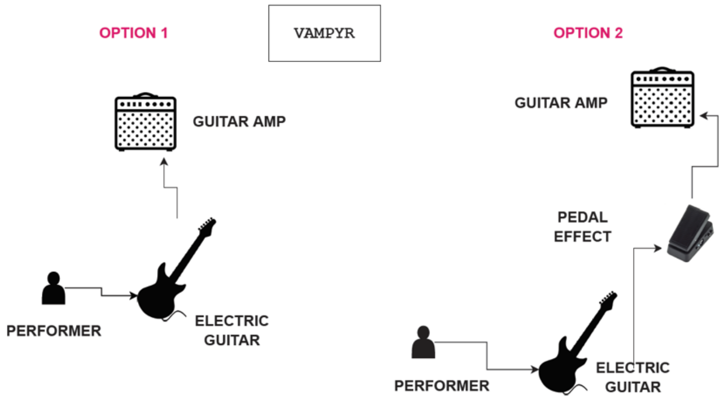


Figure 2. Comparison of two setups to perform *Vampyr*!

This writing of effects is not standardized in the notes that the composer gives, being, therefore, a choice of the performer, who over time tends to make the elements of the setup more flexible, trying to obtain more control.

This example highlights the importance of the feet when playing the augmented electric guitar. In some works, this arrangement of effects pedals on the floor will grow and the use of the feet will be very common, increasing the number of limbs needed to play the instrument.

There also begins to exist a feedback or reciprocal causal relationship between the effects derived from the sound internal processing and the indirect actions applied to the instrument, such as the action of rubbing the pick against the strings, strongly enhanced by the effect of distortion. The same will happen in other works, such as those of Romitelli *Trash TV Trance* (2002), Prins *Not I* (2007) or Sharp *Momentum Anomaly* (2006), where elements that act indirectly on the instrument take on their meaning due to the acoustic phenomena that certain effects have or that the electronics itself generates.

Finally, this phenomenon is also reflected in the use of general compositional writing. The potentialities of the sounds generated by a certain effect or aesthetic are used. For example, the use of distortion enables and increases the listening of the partial harmonics that are used in various passages of the work. The whammy bar generates very flexible *glissandi* and modulations on the pitch that correspond to the aesthetics of the composer, and that are impossible to obtain with a classical or acoustic guitar. This importance of the whammy bar will also appear in other works, especially Prins's and, to a lesser extent, Romitelli's.

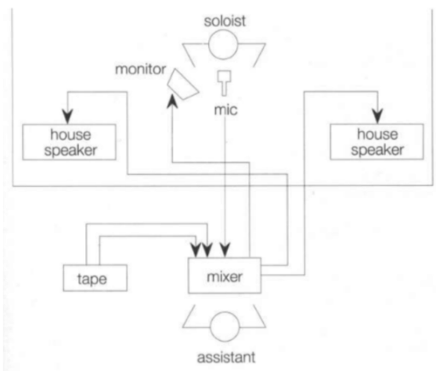
Steve Reich's work *Electric Counterpoint (*1987) introduce some peculiarities that separate it from the others analysed in this article, the writing does not use extended techniques or indirect actions on the instrument and its sound is closer to the Pop and Jazz universe than the other works closer to the distorted and loud sound of Hard Rock and Avant Garde. The work was written in collaboration with the guitarist Pat Metheny, one of the leading performers of the electric guitar in 20th and 21st centuries.

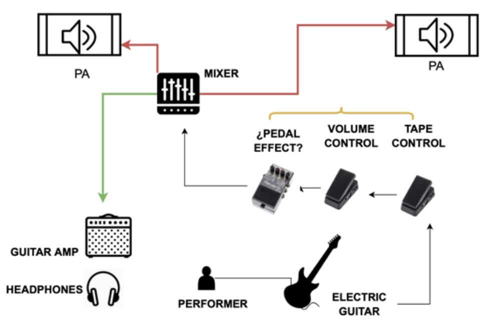
Electric Counterpoint is written for one live guitar and fixed media. In this work the performer could produce its own pre-recorded tape which includes ten guitars and two bass guitars.

> If a performer wishes to make their own pre-recorded tape they are encouraged to do so and will need to record it in a multi-track tape studio. Generally, at least 16 tracks are necessary to allow for alternate takes during the recording sessions. The multi-track tape is then mixed down to a 2-track stereo (or mono) tape for a performance (Reich, 1987).

The circuit includes the need for a PA[2] to reproduce the sound, in contrast to what is usual in the works of other authors (Prins, 2007; Murail, 1984), who prefer the sound to be transmitted through the guitar amplifier. Reich also proposes in his diagram the figure of a technician to help control the volumes of the electronics and to fire the fixed part. The amplifier appears in the diagram as a monitor for the performer (Figure 3). Although no pedal appears in the circuit, pedal effects could be used, especially the reverb pedal.

The fact of introducing a figure that controls the volume of the electronics and that releases the fixed part reduces control and freedom to the soloist who may have a different idea of the properties of the volume and the way of how the soloist and fixed part balance should be adjusted. In Prins' work, the use of a pedal is proposed to control the volume of the electronics, and this pedal could also be used in *Electric Counterpoint.* Furthermore, a pedal can be used to trigger the fixed part and this one can be chopped into at least three parts (one per movement) to articulate the pauses between movements. All this gives the performer greater flexibility, freedom and control. Full control of parts of the electronics by technicians can upset the volume balances of the works that the performer has designed. This can be solved with a faithful monitoring (amplifier or via headphones) of the balance that is being considered in the PA between live sound and electronics.





[2] Personal Address System. It refers to the audience-facing loudspeakers situated on the stage, normally in a stereo image, in contrast with the guitar amplifiers, usually situated behind the performer and in a mono image.

Figure 3. Comparison of two setups to perform *Electric Counterpoint,* on the left the one suggested by Reich in the score of the work, on the right another possibility suggested by the authors of this article.

All this conflict results in certain tendencies of contemporary performance with electronic means: a) make the fixed parts more flexible to give them more naturalness in the performance, and b) control to the maximum possible degree all the parameters of sound and electronics by the performer without depending on an external figure. However, sometimes the work is written as a duo, as is the case with Prins' work, where the electronics, that was initially proposed as a soloist part, ends up being a dialogue with the composer or the live electronic sound system.

Fausto Romitelli’s work *Trash TV Trance* (2002) is presented as a composition with Live Electronics more complex in its circuit, and requires the incorporation of a multi-effects rack, a looper station and, in certain approaches, a computer.

It happens again (as in the works of Murail and Reich) the existence of different approaches in the electronic setup. But, unlike the previous works analysed where the different configurations sought different sound results (greater control over distortion, greater flexibility in the fixed part) in Romitelli's work, alternative setups can be used to try to achieve the same result (Figure 4). In that work, the writing of the electronic part begins to be more exhaustive, and the problem is not a shortage of spelling but a difficulty in achieving the desired effect.

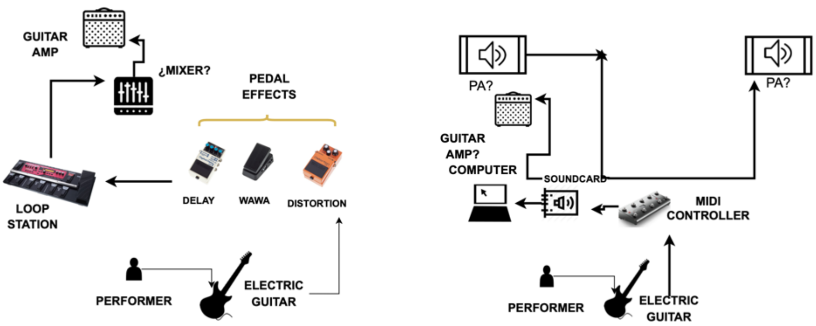


Figure 4. Comparison of two setups to interpret *Trash TV Trance*, on the left without a computer, on the right with it, options such as the mixing console or PA are also suggested.

In *Trash tv trance* the electronic parts that exist in writing are: Distortion (On / Off). Loop 1 (On / Off). Loop Inversion (On / Off). Wawa (Up / Down). Delay (On / Off). Loop 2 (On / Off). Loop 3 (On / Off). Loop 4 (On / Off) and Loop 4 Doubled (double the length of the Loop). Loop 5 (On / Off), Loop 5 ++ (add layers to the loop), Loop 5 +++, Loop 5 ++++, Loop 5 +++++.

This electronic component of the Fausto Romitelli's work is often hard to achieve. Actions such as inverting the sound of a loop or increasing its duration are not easy and not all loop effects stations can do it in real time. For this reason, the use of a computer may be necessary as a technological support. However, the work can be done without the computer if it is preferred to keep a hardware setup and control the electronics with the feet, as in Yaron Deutsch's version (Deutsch, 2009).

Romitelli's work does not have as an electronic intention only to modify the timbre of the instrument as it happens in *Vampyr!* or increase the instrumental template as in *Electric Counterpoint*, but also affects the temporality of the work through the loops, so that sounds obtained from the guitar itself are sampled and reproduced in a loop.

In *Trash tv trance* there is a huge number of objects for indirect action that are used throughout the work: a metal drumstick, a jack cable on the string, a coin, a sponge, a wooden drumstick, a bottleneck, an electric razor, an e-bow and the whammy bar. This collection is a compendium of all the indirect action mechanisms that can be applied to the electric guitar.

In that work, as in Murail's (although to a lesser extent), untuned sounds and, in general, noise play a fundamental role, which constitutes one of the aesthetic foundations of the instrument.

Elliott Sharp's work *Momentum Anomaly* (2006) is an improvisation for electroacoustic guitar, in its live performance he uses pedals and a configuration of the following type (Figure 5). In words of Elliott Sharp himself, “When I perform *Momentum Anomaly* I do often add pedals: compression, distortion, delay, pitch shifters”. The pedals shown in the diagram are illustrative and an image of his live performance could be more accurate to understand the setup. (Sharp 2019). (Figure 5.1)

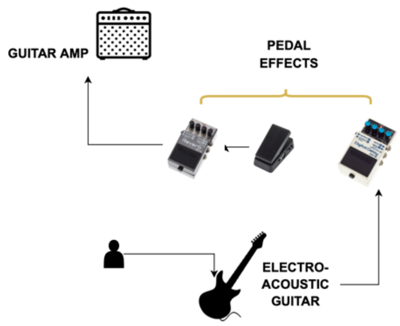


Figure 5. *Momentum Anomaly* Live Setup

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Figure 5.1 *Momentum Anomaly* Live Pedals.

From a timbrical point of view, the work is remarkable for its absorption of the electronic synthesizer aesthetic through the acoustic guitar components. This idea is highlighted in articles on electroacoustic music as the following:

> The electroacoustic composition, (...) transformed the notion of work, accompanied the development of new instruments and interfaces, and changed the performative paradigms. At the same time, acoustic music proved to be permeable to the new sounds created by electronic means (Portovedo, 2020).

Composer Sharp himself says[i]:

> (…) my self-developed extended techniques on guitar is with the end of producing sounds that are not necessarily guitaristic. It's a form of synthesis, really (…) The symphony orchestra is a very powerful synthesizer with an operating system written in the 17th century and one must hack it to produce contemporary sounds.

The electroacoustic guitar keeps the amplification due to the piezo electric microphone that it carries under the bridge and uses metal strings, therefore, it can continue to use devices that react to magnetism such as the e-bow, being an ideal instrument to become a vehicle in those works that require the use of a more present acoustic component.

Sharp's mnemonic script is structured around indirect action techniques and instruments that are applied to the guitar. This form of structuring also offers us clues about the mode of composition in works such as Romitelli's, in which the sequencing of techniques on the instrument becomes a structuring engine and a method for experimentation.

Once again noise, and sound in its broadest sense (not as a tuned sound in the form of a note) becomes a foundation of aesthetics. This also happens in the works of Romitelli, Murail and Prins.

Sharp's approach to the instrument proposes differences with other composers, since he is a musician more involved in the interpretation of the instrument, being himself the performer of many of his works and acting as a musical figure that oscillates between the performer aspects, improviser and composer. This generates different characteristics such as a less exhaustive writing and a more focused investigation in the practice of the instrument.

Stefan Prins' work *Not I* (2007) proposes complex electronics, but with fewer elements than Romitelli's work, being more synthetic in this regard. It has several characteristics that differentiate it from the rest, a very rigorous writing in terms of the expanded techniques used in the instrument (Figure 6), which shows a great knowledge and exploration of all the noises generated by the instrument.

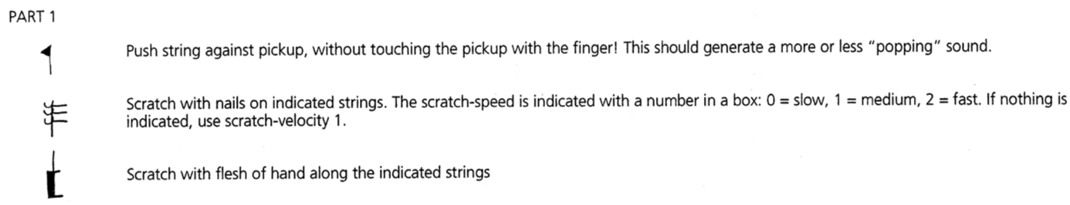

Figure 6. Some descriptions of how to generate guitar noises in Prins' score.

The electronics design features an explicitly bounded output (amp). The electronics that Prins proposed employs a volume control pedal for the electronic output (Figure 7) which is of great importance and can be applied to other works analysed.

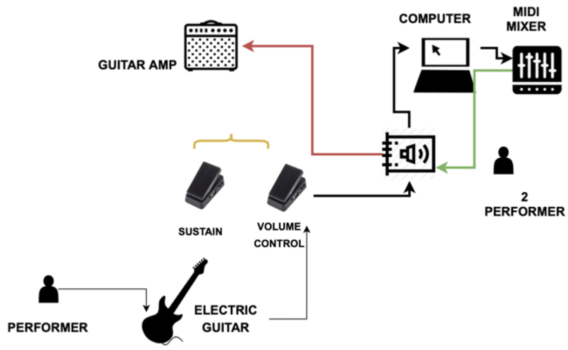

Figure 7. Setup to perform *Not I*.

This work was originally intended for a performer, and that is another peculiarity, but over time it became an interactive work between two performers (the guitarist and the composer himself). The work has several improvised passages that are combined with others whose writing is very rigorous.

> That is why until now it has not been possible for other people to perform the electronic part. Also, when I play it now with Yaron Deutsch, I am using my personal digital 'instrument', which I have built over 12 years to improvise live. This instrument (the combination of a maxpatch and the Behringer BCF2000 interface) was born working on *Not I* but has continued to grow afterwards.[ii]

Performative gestures are another of the axes and foundations of this work:

> In "Not I", after Samuel Beckett´s homonymous theatre piece, I envisioned to create a disorientating musical environment in which the relation between the physical act of playing the guitar and the resulting sound is blurred in different levels (What you see isn´t necessarily what you get!) (Prins, 2007)

Another task is taking live guitar samples or samples through granular synthesis, one of the most advanced atomic sound sampling techniques. Therefore, the Prin's work reflects two of the great epistemological concerns of contemporary music: the relationship with the musical gesture and the knowledge of the physical-mathematical phenomenon of sound. Finally, it also uses indirect action elements, in this case a small fan that is added to the whammy bar and the pick.

III

The uses of electronics in the electric guitar as an augmented instrument have various functions: increasing the instrumental template, modifying the sound, the timbre and the temporal structure, also influencing the sense of gesture.

There are also modifications in the indirect action mechanisms of great importance, some of them are beginning to be of capital importance for the instrument such as the whammy bar (which many guitars do not have) or the e-bow. This laser device is of the type of objects that interact with the electromagnetic phenomenon of the instrument.

The options for making the electronic setups of the works are variable in two ways, to achieve different results or to achieve relatively similar results. The knowledge of these setups and their possibilities becomes a fundamental part of the performer's work.

The works evolve from fixed electronics to Live Electronics system. The property of the variability of the setups makes the performer consider making the fixed parts more flexible, as in the case of Murail and Reich's works. The sound system also becomes an object of reflection, most composers sound through the guitar amplifier, but the PA option is also important and could be used in combination (using the amplifier as a monitor or amplifying the amplifier if its power is insufficient).

The appearance of another figure on stage or in technical control begins to be a reality, sometimes with the sense of external help and sometimes with the sense of a duo. What margin of control a single performer can obtain and what margin of help they may need is an important element to reflect on and may depend on the performer's degree of knowledge about the electronic part of the music.

The noise and the electromagnetic element become fundamental in the aesthetics of the instrument; several composers are beginning to contemplate the possibility of using the instrument as a synthesizer.

IV

Some conclusions that can be drawn from the foregoing affect the following aspects.

Performative / technical: Gradually there is an inversion of the role of the performer, who stops being the musician to become the agent that affects the entire sound chain. This brings the performer closer to the world of hardware so that samplers and loop stations are becoming more present, whose control requires a greater knowledge of aspects of electronics and also of composition. Furthermore, since the use of these devices is not standardized, experimentalism acquires a key importance as a learning method. Thus, the previously more closed categories of composition, performance, improvisation, and production now interact together in addressing the augmented instrument, its theories, and its repertoire. This is notable on the electric guitar, where getting a proper sound requires sound chain research.

Although the concept of augmentation refers to the fact of maintaining the technique of the instrument:

> Instrument augmentation can be defined as a process in which a given instrument's sonic possibilities are expanded by technological means, without jeopardizing the initial instrument's playing, its sonic and expressive possibilities as well as its ergonomics (Miranda and Wanderley, 2006; Lähdeoja and Navarret, 2010).

part of the instrument is transformed into its technical approach, being very important to know the possibilities of augmentation, and the creative capacity to deal with both the performance and the sonic possibilities. All this can lead to a failure to update the theoretical potentialities where a certain repertoire or musical theory does not have musicians to perform it. It can also happen that performers begin to develop their own practice without a theoretical framework, simply based on artistic exploration, as it occurs in the world of rock and in urban electronic music.

Organological: The dichotomy between external and internal instrument (in its signal processing form) becomes very important. Some external techniques only make sense with some change in the internal circuit. For example, the metal coin on the strings makes more sense if there is a lot of distortion and the e-bow only works if there is the electromagnetic phenomenon. The instrument is being magnified into two directions, external and internal. This is putting the guitar in the middle of the sound chain, not exclusively at the beginning.

Compositive / Electronic: Around the fixed parts, a series of fundamental debates will be generated that do not exclusively affect works for electric guitar but rather all instruments and groups in general. The centre of this debate is the contrast between pre-recorded electronics and electronics generated in real time. Progressively, performers are trying to make the fixed part more flexible and increase control, this encourages the development of increasingly flexible electronic systems. In order to communicate these developments, there is a tendency towards the homogenization of certain components, such as the writing of sound setups or effects, through the circuit diagram and technical rider. There is also a search for a more organic control of the effect. It is of great interest for the future to study how these effects can be controlled by gestures through mapping and body monitoring, expanding the activation and modulation gesture of the effect that is normally worked with the feet.

Social: In many cases, for composers, technologies are options or tools. However, there can be a feedback of the tools whereby, using the tool, a discovery is produced that influences the creation. This happened with Reich himself that discovered the phase effect when he investigated with recorded tapes.

> That is, technology is a means of creation and knowledge in the work of this author, whose compositional production evolved from purely electronic works without a human performer in a first stage, towards works that used learning obtained by the machine, but were performed with human means or with human means combined with electronics (Santos, 2020).

The results that electronics generates in its interaction with musical creation are often the result of chance. The social phenomenon of the arts also reminds us of the immense need for communication between musicians to understand the new perspectives and investigations that are generated in an open, interdisciplinary and experimental environment.

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[i] Quotes from personal conversations with Elliott Sharp (on 14 April 2021) by email.

[ii] Quotes from personal conversations with Stefan Prins (on 13 April 2021) by email.