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Live Electronics, Audiovisual Compositions, and Telematic Performance: Collaborations During the Pandemic

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Live Electronics, Audiovisual Compositions, and Telematic Performance: Collaborations During the Pandemic

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Abstract

We present a report of the experience of our remote musical collaboration during the Covid-19 pandemic regarding live electronic, audiovisual compositions, and telematic performance in the context of the project *Sound Notebooks*. We discuss the problems found and the solutions adopted in the performances, as well as the hypotheses of musical research raised by the remote environment. We argue that the variety of expressive modes, sonic modalities, and video possibilities in the *Sound Notebooks* repertoire we presented contributes to the construction of an aesthetics for remote performance. We additionally address practical and conceptual questions involving the composition, performance, and technical issues of the networked environment. We conceived of the environments for the remote performances through a relationship to the technical needs of the repertoire. We conclude with a brief discussion of the differences between live electronic concerts in physical and telematic spaces. Telematic performances have a complexity factor in which the musicians and audience share a virtual and perceptual space, suggesting multiple listening experiences of the same musical phenomena.

Introduction and Context

The Covid-19 pandemic has provoked massive change in many peoples' lives since the Covid-19 virus was discovered at the very end of 2019 and spread towards Western countries in early 2020. Activities that were common to our routines, such as teaching, and those related to the

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musical environment, such as composing, rehearsing, and presenting a repertoire in concerts, have changed in brutally different ways. Artistic events that happened in theaters, e.g., music concerts, shows, plays, and ballets, were completely suspended, and teaching activity was rapidly adapted to the remote domain, with many teachers, professors, and students moving to an online class format on virtual platforms such as Zoom, Google Meet, and Jitsi.

This suspension put the majority of musicians in a unique situation. In this interstice of waiting for the resumption of concerts, possibilities for coming up with new ways of making music remotely were raised. Many musicians started giving musical instruction and instrument tutorials online. Videos of solo, ensemble, and even orchestral performances were made as well. Technology is evolving rapidly to fulfill the aims of making music remotely, and the 2020 scenario has accelerated this process. Moreover, a significant number of musicians that had become used to working in physical performance spaces started to explore the possibilities of artistic expression in the network domain, as did the authors of this article.

In a typical physical concert situation, such as in a theater, we can assume that we have a unique listening experience that is shared by the performers and the public. (This shared experience can vary among those in attendance, depending on, for example, the seat in which each person in the audience is located.) On the other hand, in remote performances of networked and telematic music, each person has a different listening experience. Neither the musicians nor the audience share the same physical space (although they share a networked space); everyone is normally at their own home, which means that each person has different equipment, e.g., computers, headphones, with some using headphones while others listen through computer loudspeakers. In the new, remote schema, musicians produce sound and video that is transmitted via meeting software, e.g., Zoom, Google Meet, and Jitsi, or streamed on audiovisual platforms, e.g., Vimeo, YouTube, or Twitch. Since musicians do not share the same physical space of listening, the process of adjusting and adapting sound is slow, and several rehearsals are necessary. In fact, as musicians and composers, we never know what the resulting performance will sound like at the moment it happens. We decided to record our performances and watch them later to have a better opinion and decide what needs to change for the following rehearsals.

Nonetheless, the idea of performing music with musicians who do not share the same space is not new (a topic explored by Pauline Oliveros, Chris Chafe, Sarah Weaver, and Roger Mills, among others).[3] Telematic and networked music practice, among other forms of remote artistic

[3] For more on histories and practices with performing music in remote locations, see Pauline Oliveros et al., "Telematic Music: Six Perspectives," *Leonardo Music Journal* 19 (2009): 1; https://doi.org/10.1162/lmj.2009.19.95; Roger Mills, *Tele-Improvisation: Intercultural Interaction in the Online Global Music Jam Session* (Cham: Springer, 2019); Sarah Weaver, "Synchrony: Music of Sarah Weaver and Collaborations," *Journal of Network Music and Arts* 2, no. 1 (2020): 1–45; Ben Loveridge, "Networked Music Performance in Virtual Reality: Current Perspectives," *Journal of Network Music and Arts* 2, no. 1 (2020): 1–20.

manifestations, have been performed and studied for some time by musicians and others. [4] Within this context, terms such as telematic music and networked music have different meanings that can also be interchangeable in some cases, as argued by Eric C. Lemmon.[5] For him, telematic music is a musical practice that presents political and social goals, while networked music has a broader definition as a form of technology with the purpose of making music. Telematic music supposes two key points: first, that musicians do not share the same location; and second, that musicians perform together by means of telecommunication and electronic networks. In contrast, networked music is mostly understood as a specific term defining a field of research and practice that studies the techniques of producing music in such a distributed manner.[6]

According to Manuel Castells, the internet is characterized by pervasiveness, multifaceted decentralization, and flexibility, in addition to technologically present and culturally embedded properties such as interactivity and individualization.[7] In terms of the conceptual basis of this new universe, Vilém Flusser has written on how chamber music improvisation provides a model for telematic social structure and cybernetic organization.[8] Chamber musicians who improvise get lost in the game they invented, and even get lost in each other; each player is both a sender and a receiver of information. The message elaborated during the game means the game itself.

To Flusser's analogy, we add the analysis of the mode of existence of technical objects by Gilbert Simondon, more specifically the notion of the concretized technical object.[9] Simondon states that the process of technical concretization causes an object that is primarily artificial to become more and more similar to a natural—or spontaneously produced—object. This process occurs due to the liberation of the laboratory, factory, or workshop associated with the original, concretized object; the liberated object then dynamically re-incorporates the laboratory into the articulation of its functions.[10] In these conditions, the object is no longer isolated and can be associated with other objects, creating an "ecosystem" of objects that can be elaborated and operated upon by human beings. Moreover, the consequences of concretization can be intellectual, and the study of their operating schemes can be of scientific value.

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[4] For more on telematics, see Oliveros et al., "Telematic Music: Six Perspectives,"; on networked approaches to music in virtual reality and other online spaces, see Loveridge, "Networked Music Performance in Virtual Reality: Current Perspectives"; and for theoretical and aesthetic considerations, see Ascott, "Is There Love in the Telematic Embrace?" *Art Journal* 49, no. 3 (Fall 1990): 241–247, https://doi.org/10.1080/00043249.1990.10792697.

[5] Eric C. Lemmon, "Telematic Music vs. Networked Music: Distinguishing Between Cybernetic Aspirations and Technological Music-Making," *Journal of Network Music and Arts* 1, no. 1 (2019): 1–30.

[6] Lemmon states that telematic music is always networked music. Nevertheless, not all networked music is telematic.

[7] Manuel Castells, *The Rise of Network Society*, vol. I, 2nd ed. (Oxford: Wiley-Blackwell, 2010), 385.

[8] Vilém Flusser, *Into the Universe of Technical Images* (Minneapolis: University of Minnesota Press, 2011), 162–164.

[9] Gilbert Simondon, *Du mode d'existence des objets techniques* (Paris: Aubier, 2012), 57–58.

[10] Simondon, *Du mode d'existence des objets techniques*, 57–58.

The notions of telematic structures and the properties of technical objects helped us to conceive of the idea of the performances we prepared to be played by musicians and listened to by the public in a remote, networked space. We opted to have three types of musical pieces in the *Sound Notebooks* in order to generate interest from a wide audience. The three types of pieces we decided upon were audiovisual pieces combining recorded piano and flute improvisations, sound processing, and video art in deferred time; live electronic pieces with and without video; and recorded piano improvisations with real-time flute, live electronic improvisation, and images. The total time of the performance we conceived was approximately 30 minutes.

Live electronic music, according to Simon Emmerson, means both music produced and performed employing electroacoustic processing in real-time and music that combines instrumentalists with fixed-media sounds, e.g., tape recordings.[11] For him, "live" music requires the presence of a human performer who makes decisions and takes action by producing sounds "mechanically" with acoustic or electronics instruments; live music may also include a performer "who does not mechanically cause the sound, yet who may cause, form or influence it through electronically mediated interfaces under their immediate control." [12] The type of performer specified by the latter includes those who perform electronic sound-processing.

When building our repertoire, our choice was to work not only with live improvisation but to superimpose layers of recorded and live improvisations. Furthermore, we decided to work live with written electronic pieces that required us to develop strategies for remote rehearsals and sound diffusion. The pieces and their modes of creation, rehearsal, performance, and technical issues of realization will be discussed throughout the article. All pieces making up the final repertoire were composed during 2020 and presented at different events. The following works comprise the final repertoire:

- *Interstício de tempo* (2020), for flute and live electronics, by Danilo Rossetti (world premiere)
- *Micropoema V: Part I* (2020), by Lidia Bazarian (piano), Cássia Carrascoza (flute), and Deni Guimarães (visual art)
- *Mojave* (2020), for flute, video, and live electronics, by Paulo C. Chagas and Cássia Carrascoza (world premiere)
- *Retratos* (2020), improvisations for recorded piano (Lidia Bazarian), bass and C flutes (Cássia Carrascoza), and live electronics (Danilo Rossetti)
  1. Um modo de solidão
  2. Espaço no vazio

[11] Simon Emmerson, *Living Electronic Music* (Burlington, VT: Ashgate, 2007), 104.

[12] Simon Emmerson, *Living Electronic Music*, 90.

- *Micropoema V: Part II* (2020), Lidia Bazarian (piano), Cássia Carrascoza (flute), Deni Guimarães (visual art), and Danilo Rossetti (sound processing)

In short, this article is a report on the whole process of composition, improvisation, performance, technical issues, and solutions adopted to perform different kinds of music involving a networked domain. These items will be discussed and detailed in the following sections. The objective is to report our experiences, difficulties, and results, in addition to the presentation and discussion of our solutions to the problems we faced. The networked music environment is a very challenging virtual and vibrational shared space to perform music; it has specific characteristics, problems, and questions which are significantly different from the situation of on-site concerts with musicians and the public sharing the same space. Finally, we conclude the report by trying to establish relations between our telematic musical experience and the concepts presented and studied. [13]

Sound Notebooks (*Cadernos Sonoros*)

In the beginning of 2020, when the concert season was about to start and the Covid-19 pandemic forced many into social confinement, all concerts by the duo Carrascoza-Bazarian, consisting of flautist Cássia Carrascoza and pianist Lidia Bazarian, were canceled. The repertoire of Carrascoza-Bazarian is based on contemporary music and improvisation. In order to continue working, we realized an audiovisual project based on improvisation.

As on-site collective performances became impossible, telematic music turned into the only option. Aiming to overcome technical issues in the virtual environment, notably latency, a few game-like parameters were established. These three rules were, as follows: brief recordings (around two minutes in duration), no pre-established synchronies, and no common pulses.

The project was developed in three stages. First, the recording of the flute and piano improvisations in different locations, periodically; second, sending the improvisations to the composer, Danilo Rossetti, for developing and sound processing; and third, sending both the improvisations and the processed music to a visual artist to produce two different videos based on similar visual materials.

By following these steps, we sought to establish common concepts and emotional designs which could guide the artistic collaboration between the performers, composers, and visual artists. The overall aim of this collaboration was to achieve a dialogue between sound, music, and image.

[13] In addition to the pieces discussed in this article, preliminary results were presented in a remote concert demonstration at the NowNet Arts Conference 2020, "Network Arts and Social Distances: Capacities and Innovations," November 5–8, 2020. For a link to the performance, see "Concert Demonstration NowNet Arts Conference 2020," Danilo Rosetti, YouTube video, uploaded December 7, 2020, https://youtu.be/x8APHDwvkIs.

Moreover, an additional aim of the collaboration was to make a sound documentary of the quarantine period. Because the recordings were made at home, the surrounding soundscape was able to come through in the performances. We also kept windows open in order to emphasize the external sounds.

For sound recording, we used the Auphonic Edit app (Audio Editor for Android and Auphonic Recorder for iOS). The improvisations were recorded remotely via Zoom in order to allow visual contact and to make the sound of the flute "get into" Bazarian's house, where the piano resonance helped mixing the sounds.

With *Sound Notebooks*, we dealt with the differences between performing chamber music in a common space—where performers interact through sounds and physical gestures—and performing in the virtual environment—where performers interact through latent sounds and images. Within the virtual environment, the paradigms of bodily communication change, requiring the establishment of new rules for a new game that change the interrelation between performers.

The technical devices themselves impose certain limitations upon the musical relationships aesthetics of the project. For example, the remote situation affects the quality of the sound. However, when performers submit recordings to composers, they all work under the same technical conditions, as their methods of work do not vary depending on location. The project also causes an inversion of roles, as improvisations become compositions when interpreted by composers with digital sound-processing devices. So far, we have developed collaborations for *Sound Notebooks* with composers and visual artists in six different states of Brazil, most of them professors in state and federal universities.

We developed the improvisation according to three different creative processes. These processes were based on:

1. Intertextualities established through the reading of texts to enhance the common creative process.
2. Musical parameters established by involving a previous form, with methods including alternating players, sound materials as extended techniques, or choosing a single sound.
3. Free flow.

One of Michaela von Schmaedel's *micropoemas* is an example of intertextuality in the project. It was chosen to guide the musical ideas and performance in the work *Micropoema V*:

Life
Huge expectations planted
in tiny vases[14]

In addition to reading the poem, we predetermined to work with a single note: E-flat. The recording section took place during the month of April 2020 at 8:00 p.m.; this was the time of daily protests against the federal government. In São Paulo, people beat pots from their windows (the so-called *panelaços*) at this hour.

We then sent *Micropoema V* to composer Danilo Rossetti for his interpretation and digital sound processing. Then, the duo and Rossetti started to work with the visual artist Deni Guimarães. In order for all of us collaborate on the creation of a narrative, we shared some ideas with Guimarães that touched upon our concerns for the work as a whole: dialogue, distance, transmission, soundscape, quarantine, solitude, and confinement.

Micropoema V: Part I (2'24")

The video was layered upon the duo's improvisation, which begins with the sound of a piano, quickly followed that of an approaching motorcycle passing through the street. In the background, in a diffuse way, there are many voices, namely from the protests against the federal government, the *panelaço*. The piano and the flute dialogue with each other, in different regions of the instruments with variations of rhythms, tuning and timbre. The rhythmic gestures of the music synchronize with the visual composition. The images form a non-linear narrative; however, one recurring element consists of an image of a window with bars. When the sounds of the streets take the foreground, they simultaneously reveal the transfigured image of Brazilian president Jair Bolsonaro superimposed on a skull. The film ends with the voices of the protest and a motorcycle (fig. 1).

[14] English translation provided by the authors. Michaela von Schmaedel, *Coração Cansado* (São Paulo: Penalux, 2020), 110. The *micropoema* in its original language of Portuguese: "Vida / Grandes expectativas plantadas / Em vasos minúsculos."

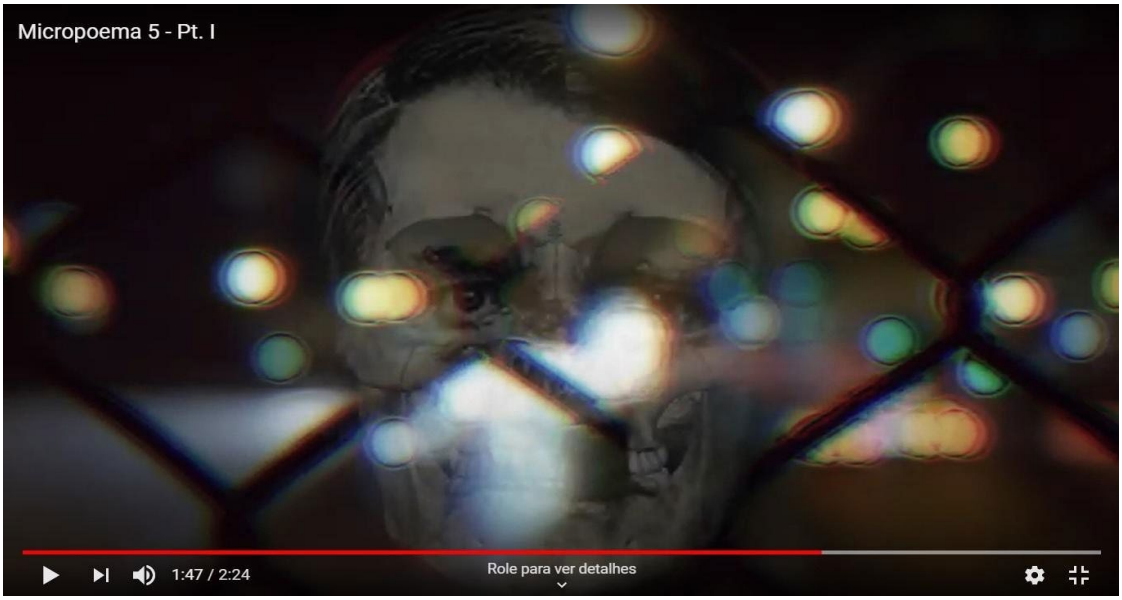

Figure 1: Still from *Micropoema V: Part* I. Imagery by Deni Guimarães, which shows Bolsonaro superimposed on a skull.

Micropoema V: Part II (2'30")

The sound was processed by Danilo Rossetti. He used computer tools to create morphological transformations of the original sounds to generate a range of timbres and spatial movements. He put the soundscape in the foreground and, although the words are unintelligible, the overall character of the protest sound is emphasized. Deni Guimarães created a new visual composition for *Micropoema V*: *Part II*, in which images of communication devices become a recurring element; these images reflect the isolation imposed by quarantine more clearly than in *Micropoema V: Part I*. The transfiguration of Bolsonaro into a skull is a recurrent element in the visual narrative as well. At one point, a sudden blackout and silence punctuates the piece for three seconds, creating the impression that the piece ends. But then it restarts and, as the instruments fade out, the voices amplify; coming to the forefront, the voices make the presence of the protests explicit (fig. 2).

Figure 2: *Micropoema V: Part II*. Imagery by Deni Guimarães.

Technical Information on Live Electronics in the Telematic Domain

Sound Notebooks features a series of other videos which were produced as collaborations between a duo performing musical improvisations and composers processing the sounds.[15] The live electronic pieces that will be discussed in this section were conceived of for streaming video. The pieces are *Interstício de tempo* (2020), a piece for flute and live electronics by Danilo Rossetti, and the other is *Mojave* (2020), a piece for flute, live electronics, and video by Paulo C. Chagas and Cássia Carrascoza. Another piece addresed in this section was conceived from recorded piano improvisations with the addition of real-time flute and live-electronic improvisations with images, as is the case of *Retratos* (2020) by Lidia Bazarian."

Rossetti has discussed the poetics of interaction and emergent properties of live electronic music in previous writings.[16] Live electronics generally deal with the notions of constructing new instruments or amplifying the possibilities of acoustic instruments. During performances of live electronic music, interpreters are in a constant feedback loop of listening and reacting: all of whom

[15] Other videos from the *Sound Notebooks* project can be viewed online. See *Cadernos Sonoros*, YouTube video, https://www.youtube.com/channel/UCFD3lpHXpiCF1rq_8wuyicA/videos.

[16] Danilo Rossetti, "The Qualities of the Perceived Sound Forms: A Morphological Approach to Timbre Composition," in *Bridging People and Sound: 12th International Symposium, CMMR* 2016, ed. Mitsuko Aramaki et al. (Cham: Springer International Publishing, 2017), 259–283; Danilo Rossetti, William Teixeira, and Jônatas Manzolli, "Emergent Timbre and Extended Techniques in Live Electronic Music: An Analysis of *Desdobramentos do Contínuo* Performed by Audio Descriptors," *Musica Hodie* 18, no. 1 (2018): 16–30.

(instrumentalists of acoustic instruments and live electronic-music performers) generate and interfere in the whole sonority and timbre of music. This sonority is formed by different sound layers that can be composed out of sounds from acoustic instruments, electronic sounds generated by audio transformations in real-time, pre-recorded sounds from fixed media, or other possibilities of interactions and assemblages. Live electronic-music performances are also dependent on the technical equipment employed, e.g., microphones, computers, patches, audio interfaces, or loudspeakers. In addition, the room acoustics where the pieces are performed is also an important feature to be considered since it can vary in each place the performances are given, interfering considerably in the sonic result. Finally, levels of mixing, amplifying gains, levels of sound diffusion, types of spatialization, and other features must be adapted for each situation.

When we started researching ways to perform live electronic music remotely at the beginning of the 2020 quarantine, the first problem we faced was how to transform the acoustic sound of the flute in real-time (in Max/MSP) and send the sounds manipulated back to the interpreter (Carrascoza) through processing techniques such as granulation, convolution, phase-vocoder, and delays. At this time, we were already aware of the possibilities that JackTrip software could offer in conjunction with JackPilot and QJackCtl, but we did not have the knowledge to solve the connection issues in our routers (such as an issue with opening port 4464 for TCP/UDP). [17] We spent a few months failing connection tests from April through August. We then asked for help from Edelson Constantino, an IT technician from the Interdisciplinary Nucleus of Sound Communication, the University of Campinas (NICS-Unicamp). He quickly solved the issue of the 4464-port opening and set up a Linux server (JackTrip -S) through which we connected remotely from our residences (JackTrip -C). Figure 3 shows a virtual meeting where Constantino presents the QjackCtl audio routing on the Linux server.

[17] Juan-Pablo Cáceres and Chris Chafe, "JackTrip: Under the Hood of an Engine for Network Audio," *Journal of New Music Research* 39, no. 3 (2010): 183–87, https://doi.org/10.1080/09298215.2010.481361.

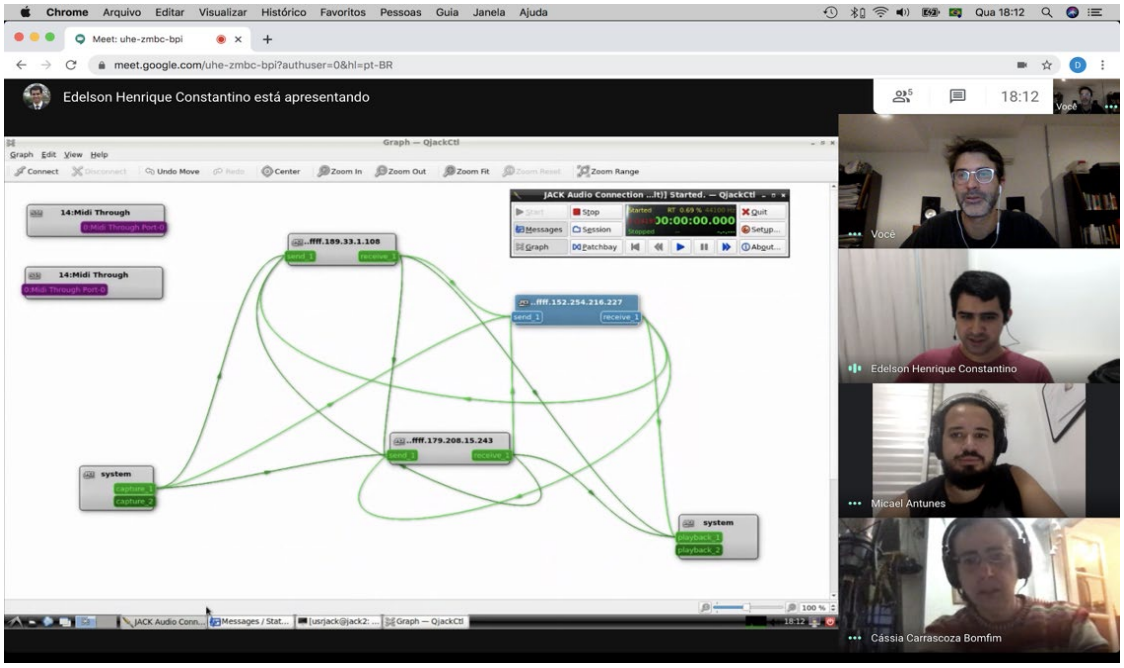

Figure 3: JackTrip remote setup meeting with Rossetti, Constantino, Antunes, and Carrascoza, September 9, 2020.

After we started connecting to each other through JackTrip, the second problem we faced was how to stream the entire audio of the pieces (acoustic instruments and live electronic processing) to the audience in a remote concert situation. After several tests, we decided to have the audio and video streamed by Zoom software. We made this decision based on the considerable audio improvements made to the software in version 5.3.2, which included the addition of stereo sound and an "enable original sound" button.[18]

Along with JackTrip, which offered one solution to our original problem of real-time processing of acoustic instrumentation, we found a second solution in SonoBus. By the end of October 2020, we heard about SonoBus, another software program that provides low latency peer-to-peer sound connections for multiple users over the Internet. [19] The first version of SonoBus (1.0.0) was released on September 28, 2020. It gives users control over the quality of audio transmission; it works either as a standalone application or also as a plug-in (VST, AAX, or AU). For our connection, we only used the standalone application. With SonoBus, all audio is sent directly between users peer-to-peer, however there is a connection server (aoo.sonobus.net) that is used so that the users in a group can find each other based on the session name.

[18] Ethan Castro, "How to Set up High Fidelity Stereo Audio over Zoom," Edge Original, Inc., accessed January 7, 2021, https://www.edgeoriginal.com/resources.

[19] Jesse Chappel, Michael Eskin, and Tony Becker, "SonoBus User Guide," SonoBus, accessed December 26, 2020, https://www.sonobus.net/sonobus_userguide.html.

Next, we discuss the possibilities and technical questions of both solutions. Figure 4 presents the desktop image of Rossetti's computer during a performance of *Interstício de tempo*. The audio routing consists of the following steps: first, the acoustic flute sounds come through SonoBus; second, this audio is then sent to Max/MSP for processing (adc~ 1 2); and third, Max/MSP sends the audio to Zoom for streaming and returns to Carrascoza via SonoBus (dac~ 1 2).

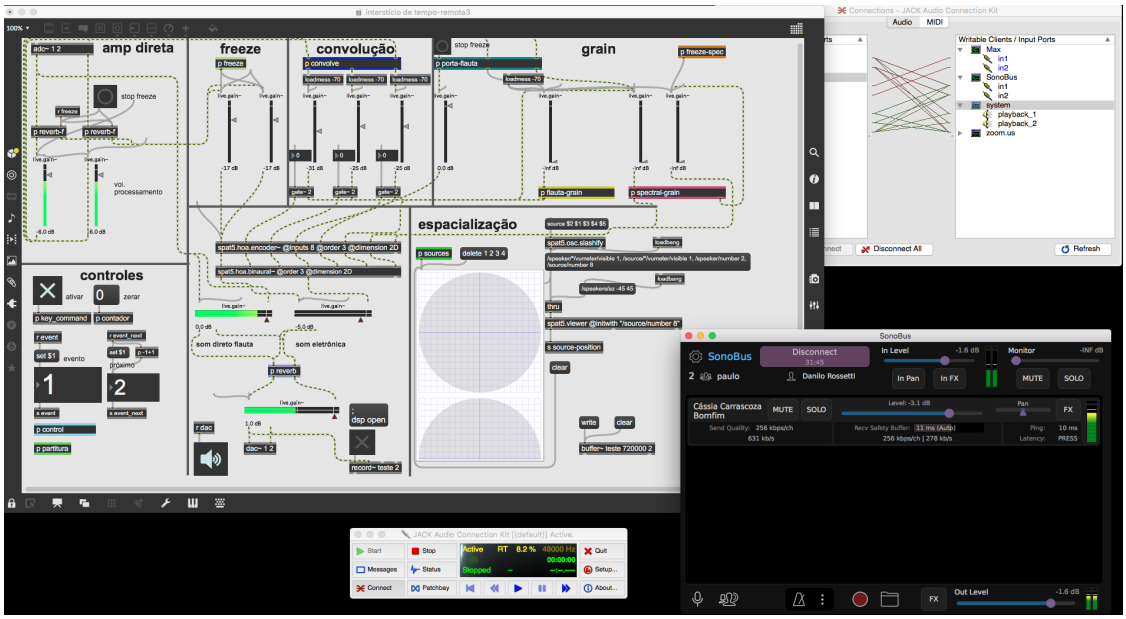

Figure 4: Rossetti's desktop setup during a performance of *Interstício de tempo*; *clockwise from left*, Max/MSP patch, SonoBus, and QjackCtl.

Solution 1: JackTrip

In order for Rossetti and Carrascoza to connect remotely using the JackTrip software, they had to execute the following steps:

1. Run JackPilot and QjackCtl on their computers.
2. Connect remotely to NICS-Unicamp's Linux server using Microsoft Remote Desktop software. (Rossetti only.)
3. On the remote server, run Qjackctl and Jacktrip -S from a Linux terminal.
4. On client computers, run Jacktrip -C from the Linux terminal to establish the connection to the server.
5. Make adequate audio-routing connections on the server and clients' QjackCtl.
6. Play!

Figure 5 presents the graphical scheme of the connections made on the server and Carrascoza and Rossetti's setups.

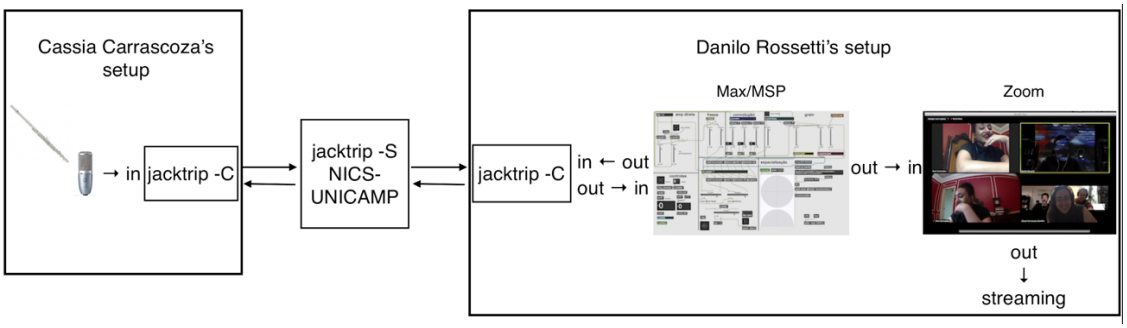

Figure 5: Client and server connections to JackTrip and Zoom

Solution 2: SonoBus

With SonoBus, the clients connected directly through a peer-to-peer connection, without the need of the port 4464 opening on routers. Thus, we did not have to connect remotely to the NICS-Unicamp server. This made connecting easier and, after several discussions and further evaluation, we opted for this solution in the concerts we performed. Figure 6 presents a graphical scheme representing the connections for the networked performance using SonoBus. The connections were implemented according to the following steps:

1. Run JackPilot and QjackCtl on Rossetti's computer.
2. Start SonoBus on clients' computers. (In this case, Rossetti and Carrascoza.)
3. Establish the peer-to-peer connection inside a specific group on the SonoBus server.
4. Make the adequate connections for audio routing (involving SonoBus, Max/MSP, and Zoom) in QjackCtl from Rossetti's computer.
5. Play!

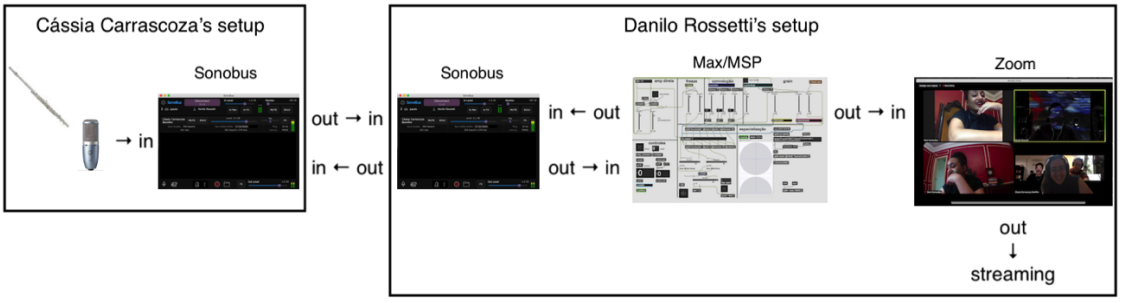

Figure 6: SonoBus peer-to-peer connection and sound streaming on Zoom

Results and Evaluation

By comparing the two solutions employed in our performance of networked, live electronic music involving JackTrip and SonoBus, we can make the following remarks:

1. In the JackTrip environment, we achieved a clear and defined sound whereas for the connections, it was necessary to connect to a remote server, run JackTrip -S, and make the audio-routing connections. (However, this process demands a higher CPU-processing speed than with SonoBus.)
2. In SonoBus, it was much easier and faster to connect between clients, although the sound quality is not as clear as that of JackTrip.
3. Regarding the streaming quality, we had very little control over the overall quality of the sound. Even though Zoom enabled stereo sound and includes a "turn on original sound" button, we were not provided with much information on the audio quality that was being streamed.
4. In that sense, in order to have a more thorough evaluation, analyses and future tests must be performed, such as analyzing the audio recordings from different sources, e.g., Max/MSP patch, SonoBus, JackTrip, and Zoom, and testing other streaming possibilities such as Vimeo and YouTube.

Acousmatic Improvisations: *Retratos*

Lidia Bazarian's *Retratos* (2020) is another kind of musical proposal. The *Retratos* are a series of short improvisations on the piano that capture interior movements, two of which were selected to be performed in the network domain. The piano material improvised and recorded by Bazarian was the basis for a new improvisation made by Carrascoza, performing bass flute and C flute, and Rossetti, performing live electronics.

The first of the improvisations, *Um modo de solidão*, has an intimate and confessional character. It features colorful textures and sonorities based on harmonic progressions. In the second, *Espaço no vazio*, Bazarian employs extended piano techniques to create delicate resonances. The rhythmic pulse is constant, and the sound spatialization allows for greater flexibility for the insertion of new improvisations. Figure 7 shows a moment of Bazarian's piano improvisations.

Figure 7: Bazarian improvising in *Espaço no vazio*

The live electronic improvisation conceived of by Rossetti in *Retratos* is based upon the sound processing of the recorded piano sounds and the concurrent improvisations of Carrascoza on the flute, which take place while the sound processing occurs. During rehearsals, the three of us decided together which electronic sonorities would have an aesthetic convergence with the acoustic sounds of the instruments.[20]

We employed sound-processing techniques including convolution, ring modulation, delay, and granulation. The parameter values of the ring modulation (referring to the frequency of the modulating wave), granulation (referring to the grain size, grain delay feedback, and rarefaction rate), and the intensities of each sound treatment were controlled by Rossetti during the improvisations with a USB fader knob-controller. Table 1 describes the sound processing employed in each of Bazarian's short improvisations.

Piece	Piano	Flute
Um modo de solidão	convolution 1 ring modulation/delay	convolution 2 granulation
Espaço no vazio	convolution 1 ring modulation granulation	convolution 2 granulation

Table 1: Live electronic processing employed in *Retratos*

[20] Danilo Rossetti, "Interaction, Convergence, and Instrumental Synthesis in Live Electronic Music," in *Proceedings of the 12th International Symposium on Computer Music Multidisciplinary Research*, ed. Mitsuko Aramaki et al. (Marseille: Laboratory of Mechanics and Acoustics, 2016), 209–216.

Real-time convolutions 1 and 2 were employed in the piano and flute sounds. They were performed with spectrally different sounds stored in a buffer. This process is similar to a "timbre-stamp" process where the "control source" (referring to the sounds stored in the buffers) stamps its spectral envelopes onto the sounds of the instruments. [21] This process depends on the morpho-logical characteristics of the instrumental sounds played, specifically in terms of their temporal and spectral components. The convolution process acts as a mirror, where common spectral areas that resonate are reflected with different modulations and projected onto the resultant sound tex-ture.

In the ring modulation process, we control the modulating frequency, associating the sonic result of the modulation to a delay line. Ring modulation is a particularly well-known effect in electronic music history—a well-known example being Karlheinz Stockhausen's *Mantra* (1970), a piece for two pianos, crotales, and woodblocks. When low-modulating frequency values are used, a tremolo effect is obtained in the piano sounds. When higher frequency values are used, different sound colors are produced, resembling bell sounds.

The granulation effect consists of dividing the input sounds (either instrumental sounds or the sound synthesis) into small (in terms of milliseconds) chunks. These chunks are then diffused by means of textures with different granular densities in the time-frequency space. [22] This effect presents a quite satisfactory interaction with sonorities presenting predominantly transient characteristics. Granulation was applied to the flute in the two improvisation pieces, whereas it was applied only to the piano sounds in *Espaço no vazio*, which used extended techniques.

Finally, it is important to highlight that during performances of *Retratos*, the improvisations by Carrascoza and Rossetti over Bazarian's piano recordings were acousmatic. Rossetti and Carrascoza did not see each other while they were playing, having turned off their cameras on the Zoom software. They just listened and reacted to each other during the piece. On the other hand, the audience and musicians in the Zoom meeting watched images of a jaguar and a rainforest in *Um modo de solidão* and *Espaço no vazio,* respectively. These images evoked the burning of Brazilian rainforests, primarily in the Pantanal and Amazonian regions, during the months of August, September, and October 2020.

Telematic Performance

As we mentioned, there are many philosophers, composers, musicians, scientists, among a variety of other scholars and practitioners, who have been researching networked music performance for some time. However, our particular approach emerged from the need to keep our

[21] Miller Puckette, *The Theory and Technique of Electronic Music* (Hackensack, NJ: World Scientific Publishing, 2006), 291–292.

[22] Curtis Roads, *Microsound* (Cambridge, MA: MIT Press, 2001), 85–118.

musical practice alive. Carrascoza played as principal solo flute for twenty years in the state opera house, *Teatro Municipal de São Paulo*, while remaining strongly active in the Brazilian contemporary music scene as a soloist and chamber musician. She has premiered a significant number of contemporary works which have been dedicated to her as well.

Oral tradition and imitation are aspects of music learning and teaching that keep music performance alive. Nowadays, with telematic performance, we lose the paradigm of traditional musical performance. In the collective musical practice of the network environment, we still have to learn how to interact with other musicians and how to communicate and expand our communicative gestures to audiences.

Flusser considers chamber music to be a form of communication that anticipates telematic communication.[23] In traditional chamber music, there are multiple layers of communication. As Chagas claims, addressing Flusser's ideas "chamber music requires interaction between bodies, voices, and musical instruments."[24] Then, he writes:

> Typical gestures of chamber music include breathing to indicate the intention of synchronizing actions, tapping feet on the floor; making movements with the head, arms, or other body parts. Other gestures involve making abrupt movements with the instrument, such as with a woodwind, the bow for stringed instruments, or drumsticks with percussion instruments. In general, musical performance produces indexical gestures resulting from the combined action of bodily movements with specific movements of the instruments.[25]

What Chagas states can be corroborated by two aspects of chamber performance that we have experienced. First, in physical space, bodily vibration is shared, and the mutual perception of the pulsating bodies equalizes the common pulse. Secondly, in chamber music, the visual perception of the different movements that anticipate the production of sound is a crucial part of the interaction between musicians. As the number of a chamber music group increases, the visual interaction becomes more complex and multiples. Furthermore, our experience shows that the interaction between musicians is based on the perception of a common time. When music is played in a shared physical space, we can say that the sensation of a common pulse guarantees the simultaneity of collective musical narratives.

When performing, the musician is always a transmitter and a receiver of sound.[26] This occurs in any circumstance, even when there is no amplification. In our experience of performing in a

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[23] Paulo C. Chagas, "Creativity with Apparatuses: From Chamber Music to Telematic Dialog," *Flusser Studies* 17, no. 1 (2014): 1–15.

[24] Chagas, "Creativity with Apparatuses," 10.

[25] Chagas, "Creativity with Apparatuses," 9–10.

[26] For more on the topic of the sender-receiver relationship in sonic modes of address, see Roy Ascott, "Is There Love in the Telematic Embrace?"; Vilém Flusser, *Into the Universe of Technical Images* (Minneapolis: University of Minnesota

mixed environment of instruments and electronic music, the interaction of sound with the space and the speakers changes the feeling of time and latency. Everything becomes more complex because there are already virtual sounds "living" in space. Simply put, sound spatialization makes sound behave differently. Therefore, the musician has to interact with the amplified sound and the different sources of sound in order to create a relationship that is similar to the interaction between chamber musicians.

Inspired by chamber music, Flusser developed the model of telematic dialogue, which Chagas considers as an attempt to synthesize two types of communication. According to Chagas, these two types of communication are:

> (1) The communication of chamber music, which occurs in the physical medium with bodies producing gestures that are translated into sounds. (2) The communication of electronic music, which occurs in the virtual medium with apparatuses producing programs that are translated into sounds or images.[27]

How can we characterize performance through this model of telematic dialogue? Following Chagas's account of Flusser, the telematic performance is a "dialogue between 'musicians' and 'intelligent memories,' which are, at the same time, transmitters and receivers of information. The goal of the dialogue is to synthesize new information."[28] According to Flusser, the telematic dialogue occurs in "simultaneous time and space"; this in opposition to traditional chamber music, which would be structured as a succession of linear events. [29] As far as our observation is concerned, perhaps we should think of "simultaneity" in terms of multiplicity rather than as events occurring simultaneously.

Up until the contemporary moment, we found it easier to interpret chamber music with electronics than playing with another interpreter in a virtual environment. This was due to how the sound latency in telematic music leads to different perceptions of time. Furthermore, as musicians do not share a common space, it is more difficult to have an accurate idea of whether sound is being produced simultaneously or not. We find it remains necessary to continue researching different parameters in order to have the synchronicity that is required to play conventional repertoires.

In one rehearsal for *Interstício de Tempo*, there were vast differences in what individual musicians heard compared to what was heard via the bi-directional music performance software. While

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Press, 2011), 162–164; Paulo C. Chagas, "Creativity with Apparatuses"; Cássia Carrascoza Bomfim, "O Problema do Tempo no Repertório de Obras Mistas para Flauta Solista" (PhD diss., University of São Paulo, 2016).

[27] Chagas,"Creativity with Apparatuses," 11.

[28] Chagas, "Creativity with Apparatuses," 11.

[29] Flusser, *Into the Universe of Technical Images*, 163.

connected to SonoBus, Rossetti and Carrascoza were working on the piece when Carrascoza realized that the usual sound processing that takes place in the third section (measure 18) did not occur (fig. 8). However, when asked about the sound, Rossetti confirmed that he was able to hear it. Adding to the differences in experience, none of the musicians in a virtual environment such as ours are able to know what the audience hears. It makes their experience similar to that of deafness.

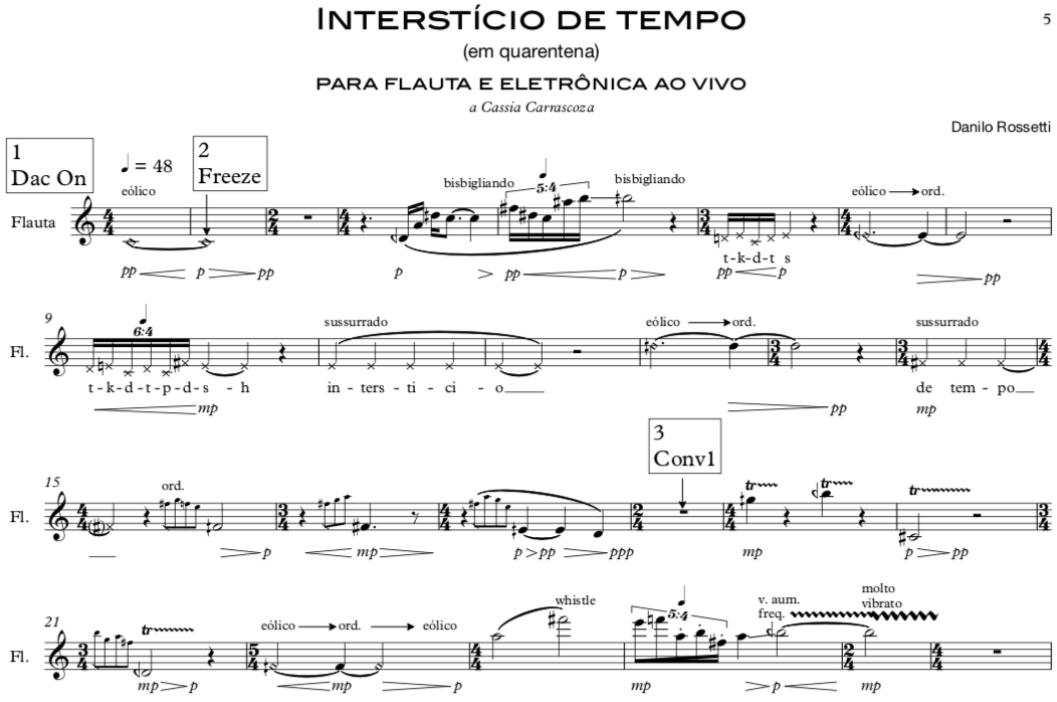

Figure 8: *Interstício de tempo* score

As performers, we are used to experiencing music in a common space that includes the musicians playing and the audience listening. It is part of performing to know how to adjust the production of sound according to the characteristics of the acoustic space. This is the reason why there is always a dress rehearsal before a concert nearly anywhere in the world. In the telematic environment, performers can only adjust their own feelings of receiving sound. In our case, Rossetti could make adjustments to the production of sound, while Carrascoza could adjust only the microphone gain and distance. As we cannot listen in the same way, we have to refine the way to express our sensations of sound, to be better at expressing with words what we perceive when sharing the same space. For the performer, this situation is similar to what happens in recording studios.

We performed *Interstício de Tempo* in a somewhat traditional manner. The piece has a wide range of flute performance techniques, spoken text, diversity of dynamics, and electronic

interaction in real time. Carrascoza performed the piece as if she were on the stage with a fixed position, score, music stands, and a microphone. However, for the audience, what was visible was the balcony of her home (fig. 9).

Figure 9: Carrascoza performing *Interstício de Tempo*

In the remote performance, our privacy became public once the performer's home was opened up to the audience. Here, we observe a peculiar situation: although we advised the audience how to set their devices to have the best visual experience, we have no control of what they are truly watching. In this sense, we are blind in relation to this aspect of communication.

When music is performed on the stage, a vocabulary is created out of physical gestures, a complex of actions that are based on tradition. This results in a ritual that includes both the musicians and the audience, e.g., when a performance ends, the audience applauds. In networked music performance, this code changes to become more dynamic, with people applauding intermittently through written comments and visual signs. This reiterates how telematic art has generally been discussed in terms of increasing the interaction between artist and audience.[30]

[30] See Roy Ascott, "Is There Love in the Telematic Embrace?"; Vilém Flusser, *Into the Universe of Technical Images*; and Paulo C. Chagas, "Creativity with Apparatuses."

Mojave, Paulo C. Chagas and Cássia Carrascoza

In 2019, Carrascoza began collaborating with Chagas in his art and technology project *Absurd Biophony* which emphasizes the creation of immersive audiovisual art that interacts with different sound environments and unusual performance situations.

Originally designed for an on-site performance, *Mojave* is a collaborative audiovisual work that includes the following elements: desert landscape, performance in the desert, improvisation, 360-degree video composition, soundtrack with sounds of flute and bass flute, and a composition for solo flute and live electronics to be performed live.

In January 2020, Carrascoza and Chagas recorded audio and video in the Mojave Desert using an ambisonic microphone and a 360-degree camera. (In this section, "we" refers to Chagas and Carrascoza.) Before going to the desert, we worked with the concept of intertextuality in order to create common emotional references. Inspired by Vilém Flusser's book *Vampyrotheuthis Infernalis*, we decided to play long sounds and extended techniques in improvisations with flute and bass flute.[31] Unpredictable sounds defined two fundamental aspects of the performance. The first was the sound of a constant, strong wind blowing, and the second was the sound of small stones scraping the floor as Carrascoza walked, which sounded like a percussion instrument.

The uneven terrain and the loud noises of these stones on the ground regulated the speed of Carrascoza's path in the desert. This action set a visual rhythm around the microphone and the camera, further defining the space and the path Carrascoza followed. All bodily improvisation occurred around this axis in such a way that the technical devices worked as ears and eyes, dictating what was possible to be recorded (fig. 10).

[31] Vilém Flusser and Louis Bec, *Vampyrotheuthis Infernalis* (Göttingen: European Photography, 1993).

Figure 10: Carrascoza performs in the Mojave Desert.

For Carrascoza, the most important action was listening to the landscape. The sounds she heard determined the musical gestures she made; her playing a reaction to the desert soundscape. Uttering words that resonate inside the tube of the flute has been a practice adopted by Carrascoza. While this technique does not necessarily create meaning for listeners, it enhances the performer's affective states and intensifies the flow of emotions.

Afterwards, Chagas edited the video and composed a score for solo flute synchronized with the visual narrative. This included working on 360-degree images and movements that were musically translated into the visual composition. The piece was supposed to be performed on-site with video projections and live electronic music shown with the live performance. However, with the arrival of the Covid-19 pandemic, the premiere was postponed. We could only restart working on the piece in telematic rehearsals with the successful installation of JackTrip.

Chagas created a patch in Max/MSP for practicing the piece. The aim of the patch was to let Carrascoza create an organic interaction with the machine that allowed her to control the digital processing of the flute. This allowed for a deep level of musical interaction, similar to that which can be accomplished with chamber music. This conception additionally permits a musical flexibility concerning tempo (fig. 11).

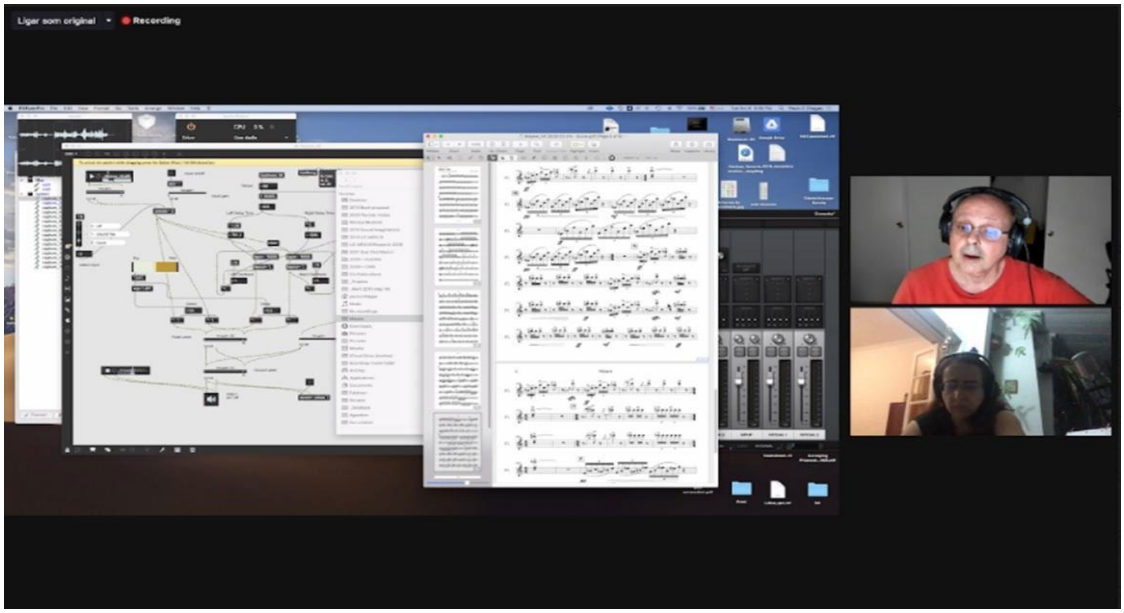

Figure 11: Telematic rehearsal of *Mojave* by Chagas and Carrascoza

During this time, we worked together to adapt *Mojave* to the reality of the telematic performance. With the decision to use chroma-keying in the virtual background of the Zoom platform, we found the possibility to overlap simultaneous images and perceptions of time. Adaptations of *Mojave* for the network situation included superposing the image of the performer to the video projection in the virtual background in order to create a visual unity.

As the original 360-degree video playback turned out to be less than fluid due to a slow Internet connection and Zoom latency, we decided to replace it with a series of still photographs taken from video recording by Chagas. On the one hand, we lost the "musicality" of the original video along with the sense of a visual narrative. However, we gained a sense of time expansion through the inclusion of still images that changed slowly over the course of the performance.

Overall, the precarious telematic situation with *Mojave* brought the following outcomes:

1. Glimpses of different bodily layers.
2. Carrascoza's bodily reality.
3. The video in the virtual background and the fragility of the device.
4. The view through the image, trespassing other layers.

The lack of contact with the audience turned the performance into a place of isolation, which is analogous to the main element of the piece, the Mojave Desert (fig. 12).

Figure 12: Carrascoza playing in the live telematic performance of *Mojave*

Final Considerations

In this section, we will highlight some of the questions and discussions that emerged from rehearsing and presenting live electronic concerts in remote environments. We also outline the next steps of this research.

As already pointed out, in a physical concert setting, musicians and audience both share the same space of performing and listening. By contrast, networked and telematic performances encourage multiple listening experiences, as individuals do not share the same physical space. Although there is not a common physical space, there is certainly a virtual/vibrational/perceptual space shared by all participants (here, the musicians and audience). The existence of multiple listening experiences becomes a complexity factor for understanding and making decisions in this environment. Musicians have to make choices about their performance knowing that what they hear in their headphones is different from what the other musicians and the audience hear. As stated previously, this complexity factor depends on the software used in sound diffusion, as well the technical equipment used by the participants.

As Castells affirms, networked communication is multi-nodal and horizontal. The interacting (musicians) and interacted (receptors) of the system are the actors that provide its form. In that sense, the network domain is, in Castells' terminology, a "space of flux" that replaces the "space of places." [32] We noticed the presence of a democratic environment where engaged participants can provide the form of—modulate—the resulting sound in many different ways. In other words, musicians in a physical concert situation, for instance, with a proscenium stage, have almost total

[32] Manuel Castells, *The Rise of Network Society*, vol. I, 2nd ed., 405–406.

control over their performances, whereas in the network domain, their control is limited by the conditions of the communication system used. The multiple possibilities of technological and interactive tools for networked and telematic performance are constantly changing and evolving, thus constituting a huge challenge to performers in regard to deciding and implementing their own solutions and network configurations for their expression.

Consequently, we notice that nearly every musical ensemble has its own technical solution to perform their repertoires inside this domain. Here, we refer to the concretization of technical objects, as proposed by Simondon.[33] The articulation and association of objects, such as computer software, into various functions by individual operators creates unique technical systems that make different artistic expressions possible.

We chose to vary the configuration of the pieces in the repertoire as a strategy to keep the audience's attention. Since the public watched the concerts on their computers or cell phones—that is, each individual in his or her own space—the existence of other, environmental stimuli was inevitable. Thus, we decided to have different possibilities of telematic performances for each piece: a live electronic piece with video (*Mojave*), a live electronic piece where Carrascoza's image was shown during the performance (*Interstício de tempo*), audiovisual pieces (*Micropoema V*, versions I and II), and improvisations (*Retratos*).

Considering that the virtual environment is constantly evolving, research on telematic musical performance needs to be revisited and redesigned on an ongoing basis. Musical communication in a non-shared space raises fundamental questions about embodiment and emotionality.

The awareness of the relationship between musicians and audience, which is essential for musical performance, radically changes with telematic performance art. As we realize that the artist is no longer the sole creator of meaning and the audience is not merely a receiver, we understand that music can and should be practiced in collaboration.

The performance of electronic music is quite suitable for the virtual environment. However, there are several adaptations that need to be made when making this transition, including to the performance itself. Some questions that emerged for us in that sense included the following: How do we transform the virtual space into a scenic space? Does it make sense to interpret traditional works? Which parameters of expressiveness in musical performance apply to the telematic environment?

These are areas in which our research is ongoing; the artistic result of which has been delivered in virtual concerts and open-rehearsal presentations. The streaming solution we adopted in this round utilized Zoom software. The next steps of this research will include an investigation of other forms and possibilities for concert streaming, as well as a more detailed evaluation of the listening conditions of the different participants involved in the networked performances (each

[33] Gilbert Simondon, *Du mode d'existence des objets techniques* (Paris: Aubier, 2012).

musician and the sound streamed to the public). In that sense, it will be possible to have a better understanding of the multiple listening phenomena related to telematic performances.

Acknowledgments

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Appendix

Links to the YouTube videos of the performances mentioned in this essay:

Interstício de tempo
Mojave
Retratos, Um modo de solidão
Retratos, Espaço no vazio
Micropoema V, Part 1
Micropoema V, Part 2

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