

2023

Musical Time in Network Interaction: The Case of unfinished line

Silvio Ferraz
silvioferraz@usp.br

William Teixeira
william.teixeira@ufms.br

Follow this and additional works at: <https://commons.library.stonybrook.edu/jonma>



Part of the [Art and Design Commons](#), [Communication Commons](#), [Computer Engineering Commons](#), and the [Music Commons](#)

Recommended Citation

Ferraz, Silvio, and William Teixeira. "Musical Time in Network Interaction: The Case of unfinished line." *Journal of Network Music and Arts* 5, 1 (2023). <https://commons.library.stonybrook.edu/jonma/vol5/iss1/4>

This Article is brought to you for free and open access by Academic Commons. It has been accepted for inclusion in *Journal of Network Music and Arts* by an authorized editor of Academic Commons. For more information, please contact mona.ramonetti@stonybrook.edu, hu.wang.2@stonybrook.edu.

Musical Time in Network Interaction: The Case of unfinished line

SILVIO FERRAZ ¹

WILLIAM TEIXEIRA ²

Abstract

Considering recent world events, art and music could not be unmoved by the dramatic turn of directions in both the way people relate and the place of technology in their lives. An ongoing project of both the authors in writing a new piece for cello and Disklavier operated by interactions in real-time gave place to a new kind of composition, mixing written music to improvisation and replacing real-time for something we are calling remote time. This paper presents such walking of resilience, first reviewing some relevant points of view about musical interaction in real-time and the importance of synchrony for musical poetics; secondly, we report technical matters of the project such as the logic of the Max patch that operates the virtual piano and the threshold between playing the notes in the score and improvising after them; thirdly, we reflect on the ways our thoughts and practices had to change. As results, we suggest that network musical interactions may point to temporal relations that can affect musical poetics even for in-person performances, suggesting new ways of conceiving musical composition. Finally, in reporting our uses of network resources, we hope this work could present potentialities of such features and also technological limitations that can be solved in the future.

Getting to the... Problem?

Philosopher Henri Bergson suggested that the shift to modern thinking started with the assumption of space as the ultimate interface for human reasoning. If the Cartesian plane were right in representing time as a succession of points, thus the geometrical method would produce true

¹ University of São Paulo/CESEM-Universidade de Évora, silvioferraz@usp.br

² Federal University of Mato Grosso do Sul/Harvard University, william.teixeira@ufms.br

descriptions of reality.³ Striving for space drove Modernity unto discovering new continents and culminated with the conquest of new planets and satellites.

However, the same Twentieth Century that witnessed the Space Race also saw after Einstein, Heidegger, and Bergson himself a new conceptual Time Race.⁴ In the late Nineteenth Century radiophonic emissions provided new experiences of listening where the production of sound was spatially separated from the reception. But the development of commercial-scale phonographs added to spatial distance the temporal distance between them both.⁵ After that, the standard experience of music became that in which the listening is temporarily split from its production, that is, the deferred time music, setting to musical composition the new challenge of dealing with multiple layers of time in its task of “making time sonorous”.⁶

The dilemma between musical realisations in real or deferred time defines a big part of different musical practices, including the threshold between several poetics and aesthetics.⁷ This force that once acted with special power in contexts of electroacoustic music, today is completely absorbed in popular music, where live performances are mostly done with MIDI sequencers and all sorts of backing tracks. Nonetheless, the temporal aspect of musical interaction remains a key feature of contemporary musical creation. The Italian composer Marco Stroppa, for instance, presents his concerns on composing music for interactive systems through live-electronics, where this kind of relationship, even when electronic sounds are produced in real-time, brings a potential of decreasing the ‘liveness’ of instrumental performance, what he points as the core of live music. Therefore, it is important to remark that for musical time to be ‘real’, it is not enough to be simultaneous to listening, but also its creative energy must be as ‘live’ as possible.⁸

In her article “The Intersection of ‘Live’ and ‘Real-time’”, Kerry Hagan develops a reading of real-time interaction after an analytical spectrum to assess the coefficient of ‘liveness’ of a live performance, taking into account the discomfort that performance may nourish about the rigid parameters of electronics in deferred time. The poles of this spectrum, when applied to the context of traditional acoustic performance, are at one hand recording in the studio following a score and, at the other, free improvisation without any guidance or notation. In the case of electroacoustic music, these poles would appear, first, as the fixed media produced entirely in deferred time

³ Henri Bergson, *La pensée et le mouvant* (Paris: Presses Universitaires de France, 1969), 19.

⁴ Heath Massey, *The Origin of Time: Heidegger and Bergson* (New York: SUNY Press, 2015).

⁵ Karim Barkati, *Entre temps réel et temps différé: Pratiques, techniques et enjeux de l’informatique dans la musique contemporaine* (Doctoral Thesis: Université de Paris 8, 2012), 8.

⁶ Gilles Deleuze, *Spinoza: The Velocities of Thought*, Seminar at the University Of Paris, Vincennes-St. Denis, 1980-1981. Lecture 10. <https://deleuze.cla.purdue.edu/sites/default/files/pdf/lectures/en/Spinoza%2010%20%281981-02-10%29%28PDF%29.pdf> (accessed 7 January 2021).

⁷ We adopt here the definition of Michel Chion (1982, 5) for real-time electronics as any sort of sound synthesis that occurs in the very time of its production. Cf. Michel Chion, *La Musique Électroacoustique* (Paris: Presses Universitaires de France, 1982).

⁸ Marco Stroppa, “Live electronics or...live music? Towards a critique of interaction”, *Contemporary Music Review*, 18(3), 2009: 41-77.

without any interference in diffusion, and later, as the free improvisation with real-time processing, also totally improvised. Hagan adopts these categories of 'liveness' to analyse degrees of freedom that in each piece a composer grants to performers.⁹

Afterward, the Twenty-First Century brought a new layer for the texture of time in making possible online playing due to the improvement of network connections but with the unavoidable latency it brings together. Still, interfaces and real-time bring several problems of computer programming technology, calculation speed, quality of response, and human-machine interaction modes. Such issues go beyond the strict area of music, being a topic even of new technologies and machines of everyday life.¹⁰

Nevertheless, those difficulties could be converted by musicians into poetic projects, which remind us of what Messiaen calls the “charm of impossibilities”.¹¹ After two decades, the question of real-time reappears with the pandemic and the musical practice at a distance with latency between stimulus-response, with musicians not being able to play together and having to work on their synchronised time-delay, with edited material, or accepting the challenge of non-synchronization in the so-called real-time, or better, the *remote time*.

The fact is that when one takes distance from the moment a problem arises. This problem becomes almost inexplicable: why the need for real-time if not for the poetic enterprise of a charm of impossibilities? The same question would apply to the gesture. What relevance does the visibility of gesture really have for listening if in a major part of music reception, gestures cannot be actually seen, as music is heard in situations of artificial acoustics, built in the studio, with artificial voices, and even the gesture produced on the stage is not exactly the same gesture the ear listens to? If we hire some person without musical training to edit an image and synchronise it visually and sonically, without any resources, how many really get the synchronisation? Many aspects of the relation between image-building speed and our brains come into play, and what seems as simple as synchrony is something that is perceived but not easily resolved.¹² It is in this sense that interfaces and real-time – issues for the development of machine technologies indeed – result either in music, as a poetic aspect, or simply a false problem.

Accepting and facing the situation, both of us authors developed a musical project keeping and adapting an ongoing process for a new piece for cello and electronics. What follows is a report of this process as it went through the pandemic.

⁹ Kerry L. Hagan, “The Intersection of ‘Live’ and ‘Real-time’”, *Organised Sound*, 21(2), 2016: 138-146. •

¹⁰ Hugues Vinet, François Delalande, *Interface homme-machine et création musicale* (Paris: Hermes, 1999).

¹¹ Olivier Messiaen, *Technique of my Musical Language* (Paris: Leduc, 1956), 13.

¹² Karen Pearlman, *Cutting Rhythms: Shaping the Film Edit* (Oxford: Focal Press, 2009). •

unfinished line: A Practical Approach

The composition of *unfinished line* was developed for a duo we have in partnership, with a cellist and a composer who also may perform the electronics. Our background involves a catalogue of traditionally written music (pieces for solo cello, duets, and cello and orchestra¹³). From this background comes much of the material that the cellist works into moments of improvisation, being able to relate to the composer's style. In addition, instrumental materials and gestures come from their experience in interpreting works from the 20th and 21st century repertoire (Berio's *Sequenza XIV*, Zimmerman's *Cello Sonata*, Xenakis' *Kottos*, etc), as well as many other partnerships with several Brazilian composers.

The score (available in the supplementary materials) has a fixed sequence in the form of a temporal grid of events, pitch registers, and harmonic domains. Generally speaking, it is constructed with long notes interspersed with grace notes. During the performance, the performer can insert moments of improvisation, while considering the harmonic domain established by the long note, *gruppetto*, or *appoggiatura*, that precedes the moment. Later the performer could return to the score in the spot they were in, move forward, or even get back to a previous spot. This is where the title *unfinished line* (*linha inacabada* in Portuguese) comes from, with each performance finishing this line. We share three versions in the supplementary materials.

The piece initially began to be designed for a joint performance of cello and Disklavier (Yamaha), through a compositional modelling patch designed in Cycling's Max. The first aspect to be highlighted regarding the patch is given to the mechanical limits of the available instrument (Yamaha's Disklavier) that does not allow long lines of repetition of notes with meter below 80 ms. The other concerns what we may call the *fine sculpture of sound*, which is linked to durations and MIDI velocity to give the electro-mechanical piano a profile similar to that of a human performer. In this sense, we chose a model of performance to think of this "virtual pianist", and designed it in such a way as to emphasise constant use of the pedal, a taste for micro-accents and short attacks but always resonating with the pedal. A second aspect concerns the gesture of the virtual piano. Its gestures have as main objects (1) the reiteration of notes, derived in part from the texture constructed by Xenakis in *Synaphai*, and (2) isolated notes from a pointillist texture as present in piano works of the 1950s and 1960s by serial composers.

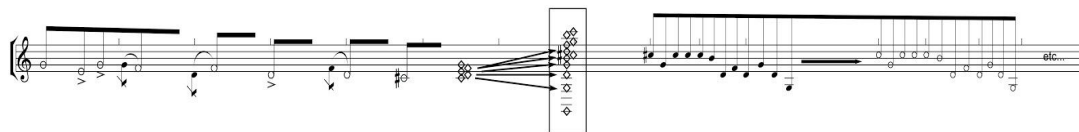
The harmonic domain of the piano responds and dialogues with the cello. It is present in the design of the patch through the analysis of spectral data by FFT via the *sigmund~* Max object. From this basic pitch material, four operators are proposed: a) deductions from fundamentals after 11-partial structures from automatic analysis via *sigmund~*; b) deduction of series of harmonics from the fundamental extracted from the automatic analysis of the signal. This series can be expanded

¹³ An important collaboration is the piece *Tríptico-Partita* for solo cello, which creative and collaborative process is reported in Ferraz & Teixeira 2019 and can be watched to in the following link: <https://youtu.be/Z5uNlvqfgpw>.

or compressed by multiplication factors; c) chord deduction emulating FM synthesis calculation, a strategy described by spectral composers, especially Murail and Grisey. It is possible to increase or decrease the number of components of each chord from the modulation index and define a moduland value.; d) deduction of chords from a series of musical intervals

Beyond those elements the long notes increase importance, on the one hand, to guarantee the response of the virtual pianist, on the other for isolating objects aiming at the producing of a musical continuity based on Ligeti's notion of stereometry¹⁴ or Feldman's extended time, both undoing the idea of a melodic line in order to adopt the notion of a proto-melody.¹⁵ However, this aspect is manifested in only one of the layers of the piece, since the piano creates a much more complex texture with its other 11 layers.

But how does the piano dialogue with the cello? First, the signal that works as the basis for the patch to trigger piano events should ideally be sent from a contact microphone to avoid ambient noise that may influence the response. However, with the performance experiments carried out, the ambient noise becomes welcome, since it integrates the place where performance is being made as a signal to be worked on. In order to control flows that escape the composition during a performance, an amplitude limiter provides the digital performer a tool to control the flow of signals that trigger events changing fundamental notes and spectral data. Such impulses are triggered by an object parallel to the *sigmund*~, that is the *bonk*~, that has great precision to identify peaks that can be counted as attacks, such as sudden peaks of spectral variation and amplitude. Secondly, The cellist, working after the score and inserting improvisation, also uses the piano sound as material for these improvisations. From the harmonic material given by the signal analysis, the piano builds not only repeated notes (fast or isolated according to the meter parameter in the patch) but can make small phrases defined by the profile drawn by a sequence of fundamental notes of the input signal; this profile is projected orthogonally on the ordered series of chords.



Ex. 1: Process of derivation after the cello sound is received

The score contains mainly two groups of structures: (1) long notes whose function is providing both a harmonic domain and a clear signal to trigger the piano while keeping textural space for the pointillist gestures; (2) grace notes which function as an energy injector to keep continuity in

¹⁴ György Ligeti, *Neuf essais sur la musique* (Genève: Contrechamps, 2001), 120.

¹⁵ Rose Brandel, *The music of central Africa, an ethnomusicological study* (The Hague: Martinus Nijhoff, 1961).

the sound flow.¹⁶ Therefore, improvisation keeps those two functions in mind no matter which notes or gestures are played. Big arpeggiated chords passages are just an extension of the function of the original grace notes; textures built through *sul ponticello* sounds are played to generate a high number of harmonics to “play” with the *sigmund*-object in a game of indeterminacy, since the levels of pressure in the bow generate emphasis in different partials, that will trigger totally different structures in the patch.

The balance between both the groups of structures happens totally in time. The score and even the patch do not direct the mood of the music. The agency between both the groups and both the players could drive the music to different affective paths. This is the reason why some structures appear in one version and maybe will nevermore be played in the others. Inside this setting, the selection of chords and *appoggiaturas* is mostly done after gestural patterns that the cellist brings – a *lick*, as jazz musicians usually do, but without any strict commitment with tonality. The affective paths are built much more with sound qualities – a “romantic” sound with lots of vibrato, or a virtuoso playing with fast bowings and a lot of left-hand action – rather than adopting chord progressions that could push the discourse towards harmonic clichés.

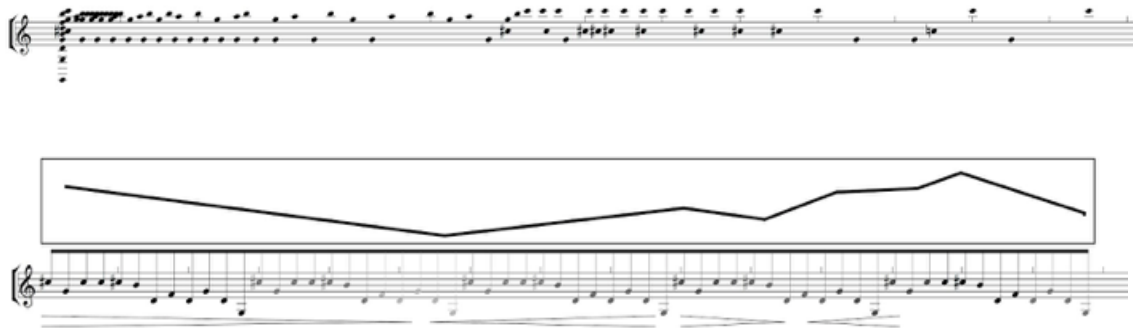
The latency of the system has a major role in the musical setting. The fact is that although based on an impulse-response system, soon after the first moments it is no longer known who responds to whom; the incorporation of different delays interplays into the compositional system for the input of responses. This means that the response to an impulse can come after another impulse since each of the partials will build 11 layers, each one with an independent temporal and figural structure. A new impulse can appear in one layer while another is still actively overlapping its harmonic materials.

Time is conceived in this composition after the notion of heterophony studied by Simha Arom¹⁷, an idea often used by a composer like Luciano Berio. Thus, each layer is conceived as carrying a cycle, which has a specific meter, rhythm and harmonic material, and texture region; and all of them can overlap and merge across delays.

The two examples below demonstrate how (1) the repetitions figures occur, with moments of iterated sounds until their pointillist expansion, and (2) the profile repetition figures, following a dynamic curve determined through a breakpoint function. In the second example the dynamic aspect is seen in three different ways, the line, the black fill of notes and the traditional signs *cre-scendo* and *diminuendo*.

¹⁶ Silvio Ferraz, William Teixeira, “Partita 3, para violoncelo solo: preparação de performance depois das notas sobre o fluxo de energia”, *ARJ – Art Research Journal / Revista de Pesquisa em Artes*. 6(2), 2019.

¹⁷ Simha Arom, *African Polyphony & Polyrhythm* (Cambridge: Cambridge University Press, 1991).

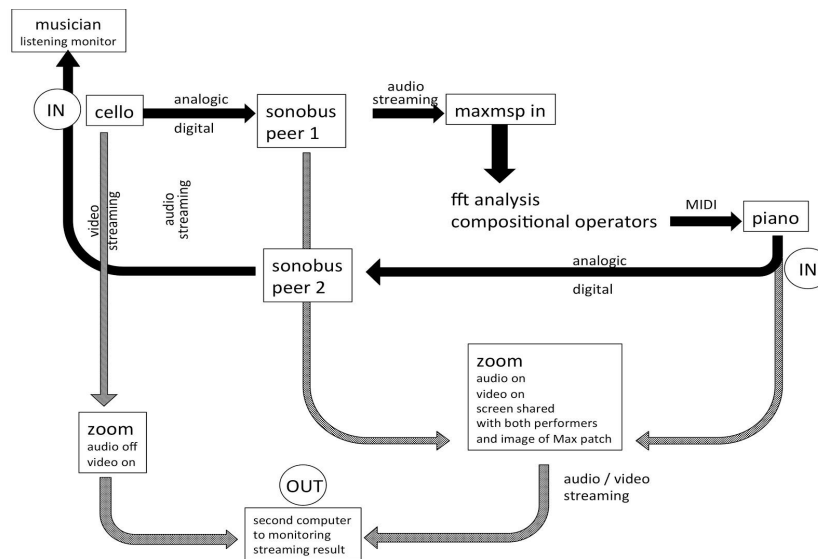


Ex. 2: a) Repetition figures with pointillist expansion; b) Figure of profile repetition with three dynamic layers

These are the aspects that allowed us to resume performance during the period of social distancing experienced in the health crisis generated by the Covid-19 pandemic, in 2020, and which in Brazil had catastrophic humanitarian dimensions. Without the possibility of personal meetings, and since the room in which the available Disklavier is locked for use because the building is closed and without an adequate ventilation system, we found a way out using a set of tools:

- a) Sonobus, a peer-to-peer network for high-fidelity streaming audio developed by Jesse Chappell, Sonosaurus LLC from several open-source software libraries
- b) MaxMSP, from Cycling'74
- c) Zoom, from Zoom Video Communications
- d) Loopback, an audio-routing for IOS by Rogue Amoeba, for managing the signals

In performance, we considered first that all data listened through a computer is in fact a synthesis, and, as synthesis, there is not an original cello sound but both cello and piano sounds as reconstructed by the computer. The Sonobus software and its effect modules allowed us to apply reverb in the output signal, contributing to place both instruments virtually in the same acoustic environment.



Ex. 3: System for performance in real-time

With this system we seek to circumvent the sidechaining that features in online meeting platforms. Usually, these network systems are developed in such a way that a main signal, both of audio and image, is always favoured, so the others are placed in the foreground. Thus, through a screen-sharing of the operator's computer, we managed to have the presence of each participant in the final image sent to the public, including the image of the Max patch in use, which can be watched in the videos available among the supplementary materials.

A New Chronotope

This reported process began as an unpretentious attempt of not stopping our ongoing collaboration, but in the middle of it, we realised that a couple of our established musical habits should be reviewed to grant 'liveness' to such an unreal time we were living in. Of course, we were aware that this was no novelty at all since as the world changes also the settings of space and time in manifestations of art capture and propose new sensations of being in the world. In this high velocity of becoming that everyone was obliged to run for their lives, we found ourselves in a quite odd setting of musical spaces and times.

But even this oddness is not a complete novelty. It is mostly covered by a concept developed by Soviet philosopher Mikhail Bakhtin as the “chronotope”.¹⁸ Bakhtin himself borrowed the notion from the physics and biology of his time to adapt it as a description of the settings of time-space – literally what the term means in Greek – in novels in their dialogical relation between fiction and history. It is a relative concept for the Hegelian absolute *Zeitgeist*, which suggested a single and sovereign spirit for each time. Bakhtin considers the singularities of each time, place, and even person since art has the pleasure of melting absolutes. And as history and lives go, literary art also evolves in the arrangements of temporalities and scenarios, defining new genres of discourse.

In musical art, space and time are present in a quite distinct way, not as denotations of history, but as existential flows.¹⁹ Although unlike language, dialogical relations still exist in high quantities in music-making. In our musical endeavour, we are drowned in flows of intensities that we try here to analyse and to reflect about. Firstly, it would be useful to list this web of dialogical relations to analyse them further:

Composer – Performer
 Score – Improvisation
 Real-Time – Deferred Time
 Smooth Time – Striated Time
 Continuity – Cut
 Performance place – Listening place
 Public venue – Domestic room
 Acoustic Sound – Electronic Sound

Any of those terms are abolished in the new chronotope that the *unfinished line* seems to establish, but only reset. It is not the case that there is no composer or no performer but that both review the roles they usually perform. The composer keeps his *metier* and technical tradition as the cellist does as well. But the same composer that writes the score and designs the patch, as usual, is invited to play the “virtual piano” in real-time as an actual chamber musician. The cellist also keeps his role of playing after a score and in making interpretative decisions, but also has the ability to even “change” the score in not playing a certain section or including improvisation spots if willing so. Improvisation here is much more an adverb, an approach in how to deal with score and its interpretation, rather than a noun that defines what the discourse is, as proposed by Benson.²⁰ There is a score with no improvisation spots because in its entirety it is open to improvisation; who decides where, how, and how much will be improvised is the cellist; but the

¹⁸ Mikhail Bakhtin, *The Dialogical Imagination* (Austin: University of Texas Press, 1986), 84.

¹⁹ Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (London: Routledge, 1962), 60.

²⁰ Bruce Ellis Benson, *The Improvisation of Musical Dialogue: A Phenomenology of Music* (Cambridge: Cambridge University Press, 2003), xii.

composer/virtual pianist also influences those choices with his instrument. The idea of impossibility and limitation is always present, also in the improvisation of the virtual piano. From just one audio transformation procedure, we can produce quite different results using the computer as if it were an instrument with a defined timbre and a wide range of possibilities for unfolding the sound extensions of an instrument.

From the standpoint of instrumental performance, the temporal experience of playing such a score aggravates what we once called the state of “extended present”²¹ in musical performance, when performers are embedded in the very moment they are playing, but always relating to what was just played and anticipating what will play next. Although this ‘meta-score’ provides moments of strict attention to notation, and others of introspection, both demand always an attentive listening to the other musician’s playing in order to decide when resuming for the score or improvisation. The charm of impossibilities enters the dialogue as the latency of remote time can become a matter of compositional poetics and performance. The signal from the cello takes almost two seconds to return to the cellist as processed by the electronics, since both the musicians did not have fiber-optic internet. This means that the sounds the cellist is listening and responding to were triggered by him two seconds earlier, and this spiral of time evolves as the music is developed.

There is another false problem concerning face-to-face practice since musicians do not look at each other so much when they play. In many practices, such as orchestras, for example, the musicians keep their eyes focused much more on the score and sometimes on the conductor. Especially in improvisations, musicians improvising are not looking at each other. It is not uncommon on these occasions for musicians to be playing with their eyes closed as if immersed in a kind of looking inward, looking at what is being heard, regardless of whether it arrived 10 or 100 milliseconds late. In music with a synchronic tradition, latency gets in the way, but musicians do not look at each other at specific times; most of the time they keep an eye on their scores, paying attention to their performance techniques, and synchronising by counting and not by looking.

When we think about time we have to keep two things in mind: on the one hand, the need for a supposedly homogeneous and measurable sequence, on the other, the presence of a heterogeneous, non-measurable time:

The qualitative heterogeneity of our successive perceptions of the universe results from the fact that each, in itself, extends over a certain depth of duration and that memory condenses in each an enormous multiplicity of vibrations which appear to us all at once, although they are successive (...) our perceptions are composed of heterogeneous

²¹ William Teixeira, Silvio Ferraz, “The Performance of Time (or the time of musical performance)”, *Performance Philosophy*, 4(2): 490–509, 2019.

*qualities, whereas the perceived universe seems to resolve itself into homogeneous and calculable changes.*²²

Therefore, we find a way of building a real-time interaction although using deferred time due to the latency of the system – from making time, to “make duration sonorous”.²³ Both of us are interacting with the sound that we listen to in real-time, even if these sounds are not produced in actual real-time. But it does not matter, since there is no metrical hierarchy or synchronic events. That does not mean that there is any pulse. Each musician keeps a temporal flow, especially the electronic with multiple layers of meters. Gestural passages suggest a striated time that allows the feeling of pulse even if without isochronism; long notes provide a smooth temporal layer that forms a multi-layered temporal texture that results in the *remote time*, where both the musicians interact with the sounds they are listening to in real time, even if the latency detaches these sounds from actual moment of its production, intertwining real to deferred time.

Moreover, there is the loneliness of being alone in a room, since each one is in his home. Rather than a mere online chat, monologic sound emission is engaged in true dialogue and exchange of affective forces during the performance. Each one makes public the intimacy of his domestic life with all its particular soundscape; the chant of macaws in Mato Grosso do Sul is added to the noise of a stone crusher digging a street in São Paulo. Everything is synthesized in a single sound flow, merging distant spaces on the screen and in the headphones of some person in Amazonas or abroad.

Final Remarks

After the reflection on the previously reported process we note that both the musicians were led to learn several new musical and networking skills for being able to engage this musical project. These new skills are now part of our musical toolbox and, as reported, expanded the cellist and the composer we are. The *unfinished line* itself has gained its own life. A new version adopting FM synthesis instead of the piano sounds was presented in a preliminary stage at the Portuguese Musical Research Meeting, in Aveiro, in November 2022, and the final one will be premiered at Harvard University in April 2023 with a stand alone setting where the cellist has to perform both the parts of the dialogue. Besides the musical structures itself, the main feature that remains from the remote process was the fluidity between events and the dialogical relationship between instrument and electronics.

Finally, we would say that this experience has proved ultimately the role of performance as analysis. There is a score and there is a patch. But only the analysis each performer does in real-time can provide the true knowledge of the layers of meaning in between the structures. Each

²² Henri Bergson, *Matter and Memory* (New York: Zone Books, 1988), 70, 181.

²³ Giacinto Scelsi, *Les anges sont ailleur* (Arles: Acte Sud, 2006), 97.

performance is an analysis of the score, resulting in different unfolding structures. The unfinished line is always the same, impossible to be apprehended out of time²⁴. Of course, we could analyse its phraseology and apply some structural deconstruction. But an immanent analysis happens in time and asks: “Is it possible, without denaturing it, to shorten the duration of a melody? The inner life is just that melody”.²⁵ Likewise, the life of music exists only in time, whether real or deferred, but always actual.

Acknowledgments

We appreciate the support given to this research by the National Council for Scientific and Technological Development – CNPq and by the São Paulo Research Foundation - FAPESP.

Works Cited

- Arom, Simha. *African Polyphony & Polyrhythm*. Cambridge: Cambridge University Press, 1991.
- Bakhtin, Mikhail. *The Dialogical Imagination*. Austin: University of Texas Press, 1986.
- Barkati, Karim. *Entre temps réel et temps différé: Pratiques, techniques et enjeux de l’informatique dans la musique contemporaine*. Doctoral Thesis: Université de Paris 8, 2009.
- Benson, Bruce Ellis. *The Improvisation of Musical Dialogue: A Phenomenology of Music*. Cambridge: Cambridge University Press, 2003.
- Bergson, Henri. *La pensée et le mouvant*. Paris: Presses Universitaires de France, 1969.
- _____. *Matter and Memory*. New York: Zone Books, 1988.
- Brandel, Rose. *The music of central Africa, an ethnomusicological study*. The Hague: Martinus Nijhoff, 1961.
- Chion, Michel. *La Musique Électroacoustique*. Paris: Presses Universitaires de France, 1982.
- Deleuze, Gilles. *Spinoza: The Velocities of Thought, Seminar at the University Of Paris, Vincennes-St. Denis, 1980-1981. Lecture 10*. <https://deleuze.cla.purdue.edu/sites/default/files/pdf/lectures/en/Spinoza%2010%20%281981-02-10%29%28PDF%29.pdf> (accessed 7 January 2021)

²⁴ We are clearly referring to the terminology conceived by the composer Iannis Xenakis to speak of categories of time in musical experience. Out-of-time structures are related to abstraction and theoretical relation; an in-time structure, on the other hand, deals with relations that appear in the very moment of performance. Cf. Iannis Xenakis, *Formalized Music: Thought and Mathematics in Composition* (New York: Pendragon Press, 1992).

²⁵ Bergson, *La pensée et le mouvant*, 11.

Deleuze, Gilles; Guattari, Felix. Minneapolis: University of Minnesota Press, 1987

Ferraz, Silvio e Teixeira, William. Partita 3, para violoncelo solo: preparação de performance depois das notas sobre o fluxo de energia. ARJ – Art Research Journal / Revista de Pesquisa em Artes. 6(2), 2009.

_____. Técnica Estendida e Escrita Polifônica em Luciano Berio: Sequenza XIV. In: Flo Menezes. (Org.). Luciano Berio: Legado e Atualidade. São Paulo: Editora Unesp, 2015.

Hagan, Kerry L. The Intersection of ‘Live’ and ‘Real-time’. Organised Sound, 21(2): 138-146, 2016.

Ligeti, György. Neuf essais sur la musique. Genève: Contrechamps, 2001.

Massey, Heath. The Origin of Time: Heidegger and Bergson. New York: SUNY Press, 2015.

Messiaen, Olivier. Technique of my Musical Language. Paris: Leduc, 1956.

Pearlman, Karen. Cutting Rhythms: Shaping the Film Edit. Oxford: Focal Press, 2009.

Polanyi, Michael. Personal Knowledge: Towards a Post-Critical Philosophy. London: Routledge, 1962.

Scelsi, Giacinto. Les anges sont ailleurs. Arles: Acte Sud, 2006.

Stroppa, Marco. Live electronics or...live music? Towards a critique of interaction. Contemporary Music Review, 18(3): 41-77, 2009.

Teixeira, W., & Ferraz, S. The Performance of Time (or the time of musical performance). Performance Philosophy, 4(2): 490–509, 2019.

Vinet, Hugues & Delalande, François. Interface homme-machine et création musicale. Paris: Hermes, 1999.