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Connectivity, Presence, and Time: A Pedagogical Experience with Telematic Music

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Abstract:

This article aims to discuss the notions of connectivity, presence, and time in the specific context of telematic music. To do so, we describe the work of the Telematic Ensemble LaFlauta, formed by students and professors from the University of São Paulo, Ribeirão Preto campus, for performance at the NowNet Arts Conference 2023.⁴ This work involved rehearsals and performances of three compositions dedicated to the group: Virtual Studies (2023) by Paulo C. Chagas, Modules 2 - My Words (2023) by Cássia Carrascoza, and Textural Studies (2023) by Danilo Rossetti. We conclude that the positive results of telematic music in a pedagogical setting are the acquisition of technological skills and the improvement of musicianship in chamber music.

Introduction

Telematic music has been, for many years, an important topic of research involving music and technology. Our research on this topic took place during the social isolation imposed by the COVID-19 pandemic. With the impossibility of sharing common spaces, the quest for solutions to continue musical practices remotely intensified.⁵ One of the potential positive actions emerged through telematic music, defined by Pauline Oliveros as “music played live and simultaneously in different geographical locations via the Internet.”⁶ In other words, it is a collective musical practice that does not take place in a common physical space; musicians are in different locations, and communication occurs through network connections.

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This article approaches the creative process and performance of three works composed for the Telematic Ensemble LaFlauta, constituting an audiovisual telematic environment. The entire artistic-pedagogical work of the Telematic Ensemble LaFlauta was developed under the concept and sonic environment that Paulo C. Chagas created for his Virtual Studies, and based on his Max patch.

To advance our ideas and develop an artistic and pedagogical project, we are engaging in various aspects of telematic music practice, serving as performers, collaborative composers, video editors, authors of Max patches, and sound technicians. We will present a case study that encompasses processes from our pedagogical work, organized across various initiatives that we launched in 2023. These initiatives resulted in a concert demonstration by the Telematic Ensemble LaFlauta at NowNet Arts Conference 2023.

The acoustic characteristics of the telematic environment provide different sonic responses from the musicians. The musical aesthetic itself has been historically shaped in accordance with the acoustic characteristics of the spaces in which sound propagates. Christopher Small highlights how the resonance of sound in physical space has become a communicative element in music. He describes how the conception of musical works in different periods of history incorporates the interference of sound latency into their structures:

No large space, of course, can be without some sonic resonance, and over centuries musicians and listeners alike have come to accept, and eventually to feel the need for, a certain amount of resonance in the sound as an element in the communication. Those who composed for performance in the great and very resonant Gothic cathedrals wrote into their masses and motets an allowance for the enormously long time, sometimes several seconds, that it takes for each sound to die.7

Resonance is a phenomenon that occurs in physical space. In the virtual environment, we work with sounds converted into digital signals. For these sounds to be recognized as resonant by musicians or the audience, that is, to reproduce spatialization situations in these environments, it is necessary for the environment to be sonically modulated.

Telematic music is subject to the potential sonic and visual characteristics of the virtual environment. This is directly linked to the constantly evolving technological possibilities, as Chagas and Bomfim affirm:

Unlike traditional chamber music, which is structured as a succession of linear events, such as themes and variations, telematic music creates a dialogue that ‘occurs in a simultaneous time and space, and all players in all places make decisions relating to themes and their variations all at

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Telematic music offers the possibility to reshape musical performance in virtual spaces by reconstructing the subjectivity with the experience of presence.

We could define, therefore, that in the non-shared sonic space, the perceptual properties of resonance created from sound behavior in the common space do not have the same characteristics, and this is an aspect that in telematic performance alters the relationships of listening, visual communication, and time among musicians. In telematic musical performance, particularly in cases where the images of performers are visible, it is necessary to reshape corporeal aspects. This involves assigning a unique syntax to physical gestures that emphasize musical expressiveness in the virtual context. Additionally, it requires addressing the physical absence of the audience, which is also a parameter of corporeality.

In his article "Creativity with Apparatuses: from Chamber Music to Telematic Dialog," Paulo C. Chagas theorizes about the telematic dialogue model proposed by Vilém Flusser, synthesizing two different types of telematic musical communication:

(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. He [Flusser] describes the telematic performance as a dialog between “musicians” and “intelligent memories”, which are, at the same time, transmitters and receivers of information.

Telematic music can make use of various configurations of acoustic instruments and can also be performed with electronic music technology, such as electronic instruments, synthesizers, sound processing, and computer devices.

Considering the periods of the creative processes of the composition of the works, the rehearsals, performance in the NowNet Arts Conference 2023, and the discussion after the performance, we elaborated three hypotheses that may guide our artistic research:

1. The chamber music ensemble (in this case, the Telematic Ensemble LaFlauta) communicates beyond sound interaction, through parameters such as corporeality, physical gestures, breathing, heartbeats, and eye contact, among others.

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2. The telematic environment is a relevant pedagogical tool for practicing electronic and mixed music. This environment is useful for developing an active listening and creating musical connection among participants.

3. Referring to Roy Ascott, the telematic environment is unique in terms of perceptual features because musicians are at the same time participating in the performance and acting as spectators of themselves, because they see their image mirrored on screen during the performance.

Thus, we seek to interpret what the implications of this type of perception-action system are in relation to the actions and decisions of musical performance. Also, we aim to analyze the perceptual features involved in active listening in the telematic environment.

Our aim for this project is to continue exploring telematic music as a mode of musical interaction across various layers of practice, including creative, pedagogical, technological, and performative aspects. Our primary focus is on musical performance and the creation of diverse sonic spaces in virtual environments.

Next we will address the theoretical concepts of connectivity, presence, and time that guide this project of composition and performance in the telematic environment. In the following, we will make a case study of our own experience working on the project “Telematic Music: Connectivity in Virtual Environments” with the Telematic Ensemble LaFlauta, performance students’ group of Faculty of Philosophy, Sciences and Letters at Ribeirão Preto - FFCLRP-USP.

**Theoretical Framework of the Research**

Three theoretical concepts guided the artistic process through composition, rehearsal, and the performance held at the NowNet Arts Conference 2023. These concepts are connectivity, presence and time.

**Connectivity**

The word connectivity applies to the connections between systems that communicate with each other, enabling them to share data or information, often through a communication network.

From this definition, would it be correct to assume that in the virtual environment, where we communicate through digitized sounds and images, we begin to see ourselves and exist as one program code? Therefore, can we understand that our presences become part of this chain of interconnected devices? Could we perceive ourselves as avatars on the computer screen?

Chagas and Bomfim claim:

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The telematic paradigm involves not only the technology of interaction among human beings but between the human mind and artificial systems of intelligence and perception. It transcends the body, amplifies the mind into unpredictable configurations of thought and creativity, and can contribute to the emergence of a global consciousness.\(^{12}\)

The musical practices in the telematic environment have been supportive to artistic collaborations and can constitute a space for new forms of audiovisual expression and affective coexistence. Similar to Flusser (2011), we understand that telematic communication has the potential to radically transform the way we communicate.

**Presence**

The concept of presence has gained importance recently due to the large amount of research and tools of virtual reality available.\(^{13}\) It is important to note that the concept of immersion is strongly connected to that of presence. In telematic music, presence and immersion are equally relevant because in this environment, internet connections are created between musicians and the public who participate in or watch performances in a shared virtual space, a plane distinct from the physical space in which we live. This created space has specific characteristics of presence and immersion. We will discuss some issues related to these characteristics that arise within the scope of this work.

We approach some definitions of the concept of presence. For Kwan Min Lee, presence refers to the psychological state attained in which the virtuality of the experience is not perceived.\(^{14}\) Regarding the emergence of virtual presence, Carolin Weinrich, Philipp Komma, Stephanie Vogt, and Marc Latoschik state that it is determined by the direction of the audience's attention towards the virtual environment, at the same time as the physical environment is occluded.\(^{15}\) Mel Slater, Beau Lotto, Maria Marta Arnold, and Maria Sanches-Vives elaborate: the more a virtual system has different sensory modalities analogous to the real world, the more this system will be immersive. Presence, in turn, is a subjective human reaction to immersion because different individuals may experience different levels of presence in the same immersive system, or different immersive systems can promote the same level of presence in different individuals.\(^{16}\)

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12 Chagas and Bomfim (2023), 329.
With these ideas in mind, in our telematic performance system, the video of the musicians is captured by the computer's front camera and transmitted to the audience using Zoom software. This choice results in the reproduction of fragmented bodies on the virtual stage that assembles all the musicians that participate in the performance. Although this configuration creates a virtual space shared by the musician and audience, it does not afford a high level of visual or spatial presence.

Based on this observation, we concluded that, in relation to the multimodal perception of the audience and the musicians themselves, the creation of an environment of greater immersion and presence in telematic music depends substantially on the sound and musical time developed in the works composed for this environment. The construction of the sound of the musical works is related to the type of instrumental writing or improvisation carried out, instrumentation, and types of live electronic processing used. Audiovisuals also contribute to a greater level of immersion and presence by combining visual and sound elements in the same work, contributing to create a more evident virtual reality.

Time

We found the work of two philosophers to be particularly useful for thinking about musical time and the level of immersion and presence achieved in telematic compositions and performances, namely Henri Bergson's concept of duration and Gilbert Simondon's concepts of transduction and modulation. These ideas are connected to the notion of presence associated with telematic music, and specifically to our project, which includes compositions and performances of live electronic music and video. As mentioned above, these performances generate a level and sensation of presence for the audience watching them, due to the virtual environment that is created.

Bergson's idea of duration is relevant to the manipulation of the perception of time in music. It distances from the idea of a measured (extensive) and chronometric time that could be found in the score of works and approaches the time of perception insofar as this time is inextensive and qualitative: in other words, an unmeasured time. This pure duration of Bergson is characterized by the succession of states of consciousness that interpenetrate and merge, without being separated or divided.17

Another possibility for Bergson's pure duration would be an analogy with the ideas of immersion and presence, insofar as immersion in a virtual reality, for example through the telematic performance we are developing, promotes an interpenetration or fusion of sounds and images perceived by the audience. This aggregate of sound and visual images, combined with other stimuli and sensations, promotes the emergence of a perceived duration, related to the musical time of the works.

The concepts of transduction and modulation developed by Gilbert Simondon are also useful for conceiving the evolution of time in telematic works. Transduction, in general terms, is the transformation of one energy into another energy of a different nature. From this definition, Simondon thinks of the transduction as an operation (physical, biological, mental or social) in which an activity

spreads little by little within a domain, such as a structural modification that is progressively extended.\footnote{18 Gibert Simondon, \textit{L’individuation à la lumière des notions de forme et d’information} (Paris: Jérôme Millon, 2005).} In live electronic music, within the instrumental sound spectrum formed by partials or grains, there is a progressive transformation of the instrumental spectrum by electronic processing, through modifications to the timbre that emerge from these processes.\footnote{19 Danilo Rossetti, “Projetando o espectro do som no espaço: imagens-movimento de parciais e grãos sonoros,” \textit{Orfeu} 5, no. 1 (2020): 571–594.}

For Simondon, modulation takes place in the domain of the macroform, or the perceptible form of processes. Modulation is the transformation of an energy into a form, a continuous mold that defines its contour. To modulate is to mold in a continuous and ever-changing way. The evolution of the sound texture of works over time can therefore be thought of through the concepts of transduction (at the microtemporal level) and modulation (at the macrotemporal level), through the control of musical time, especially in the case of mixed music through the interaction and confluence of instrumental and electronic sounds over time. In telematic music, this condition is amplified by the virtual reality established in the connections between the musicians and the audience that take place in this singular space that is created at the moment of the performance.

\section*{The Telematic Ensemble LaFlauta}

The Telematic Ensemble LaFlauta is a group of music students from the Music Department of Faculty of Philosophy, Sciences and Letters at Ribeirão Preto - University of São Paulo. It includes the participation of professional musicians, whether they are composers or instrumentalists.

The ensemble is coordinated by Professor Cássia Carrascoza. It was created in March 2021 with undergraduate flute students to be part of the project "Connecting Creative Communities: Our Music, Our Stories," conceived by Professor Chagas. The project involved the collaboration of students from the Concert Band at the University of California, Riverside, under the direction of Professor Lauren Wasynczuk, and the La Flauta Ensemble. The group made its debut at the Que Viva México! conference on May 16, 2021, at the University of California, Riverside. From 2021, in addition to flutists, the group has included a singer, a percussionist, a violinist, and two guitarists, among other instrumentalists.

In 2023, the group joined a project titled "Telematic Music: Connectivity in Virtual Environments," funded by the São Paulo Research Foundation—FAPESP. This enabled the acquisition of equipment permanently housed at the University of São Paulo in Ribeirão Preto, in the Flute Laboratory—LaFlauta. The acquisition includes the following equipment:

- 1 Macbook Pro
- 1 Sony camera (SONY ZVE10) and tripod
- 1 audio interface (Scarlett Focusrite)
- 1 microphone (Shure SM57)
- microphone stands and cables
Moreover, individual equipment was loaned so that students can participate in the group from their homes:

- 4 audio interfaces (Scarlett Focusrite 2i2)
- 4 microphones (Shure SM57)
- microphone stands and cables

On May 27, 2023, the Telematic Ensemble LaFlauta performed *Modules 2 – My words* for telematic ensemble and live sound processing, a piece by Carrascoza, with an audio system including JackTrip, Loopback and Max/MSP. The performance was held in the 4th International Cycle of Sonic Convergences - Telematic Music: Connectivity in Virtual Environments, organized by Carrascoza at the Music Department in USP at Ribeirão Preto. The concert also included the participation of Trio Janela, Gloria Damijan, Eric Lemmon, Jane Wang, Mike O’Connor, and Alexandre Ficarelli.

Since July 2023, we have been working with a Pretty Good JackTrip Toolkit - (PGJTT) server with the capacity to accommodate the group. This initiative aimed to achieve a better sound quality, consequently enhancing our musical interaction, as we will discuss later in this article. Our final objective was to set up an audio system incorporating PGJTT, Loopback, and Max/MSP tools, working with our students to develop a complete concert program featuring pedagogical telematic chamber music pieces. This program was presented as a concert demonstration during the NowNet Arts Conference 2023 on October 31.

The pieces performed were *Modules 2 – My Words* (2023) by Cássia Carrascoza, *Texture Studies* (2023) by Danilo Rossetti, and *Virtual Studies* (2020) by Paulo C. Chagas (see additional files).

For the performance, we utilized three Macintosh computers, with two assigned to the professors and one to a student, while the rest of the students worked with PC machines running Windows. Most participants could directly configure JackTrip using the RTaudio option in the JackTrip GUI to connect to the server, although some students needed to use the Graph tools in the QjackCtl program in order to route the audio connection correctly.

We list below some technological and pedagogical aspects addressed with students: connecting the set of audio devices on the computer: interface and microphone, along with accessories, tripods, and cables, installing the JackTrip software for live sound sharing, researching the best microphone.

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20 The concert may be viewed on YouTube here: https://youtu.be/-hURtGk_RCs?si=_l2AV210y1piBiFQ and here: https://youtu.be/cXmNPmY48Ts?si=X1ztzc5ozjQKv0yQ
21 Trio Janela is formed by members of the NowNet Lab Ensemble: Viv Corringham (vocals and electronics), Diane Roblin (piano and keyboards), and Cássia Carrascoza (flute and audiovisual streaming production).
positioning for each instrument, enhancing self-listening, cultivating sensitivity and intuition to interact with live processing (Max/MSP) and network latency.

Playing in a telematic ensemble demands a reinterpretation of various aspects compared to traditional chamber music. For example, while pulse is crucial in the Western European classical chamber music repertoire, in telematic music, simultaneity might occur accidentally.

As a kind of conducting in all the three pieces performed, we used the same system we had created for our 2021 project "Connecting Creative Communities: Our Music, Our Stories":

The performance cues were given through the Zoom chat tool by writing the name of each musician. In order to promote a state of continuous attention and to establish a kind of game relationship among the students, I decided to always change the order when they play. With this strategy I aimed to stimulate peer listening and sound interactivity.25

We used the piece Modules 2 as a pedagogical tool to practice general aspects of chamber music, such as tuning, dynamics, musical phrasing, and Musical listening.

The professors Rossetti, Ficarelli and Carrascoza worked on a weekly basis with students technical and musical aspects. The members of the Ensemble LaFlauta were: Prof. Alexandre Ficarelli (oboe), Prof. Cássia Carrascoza (direction, flute, live electronics, technical production and video edition), Bartira Soares Sene Pereira (voice), Letícia Rodrigues Pessica (acoustic guitar), Lucas Herrera Andrade Diniz (flute), Luiz Gustavo Chapina (violin), and Orlando Cagnini Miotto (mandolin).

**Technical Tools: PGJTT**

The Pretty Good JackTrip Toolkit (PGJTT) is an ongoing project by Mike O'Connor to serve as a telematic music practice tool, aiming to enhance sound quality. This is an image on a server, configured as a cloud server hosted on Linode, can be accessed via Virtual Network Computing (VNC). Musicians can set up and utilize it as a mixer and recorder to improve their performance experience. Using open-source or inexpensive technologies, the tool was constructed with careful consideration for simplifying technology usage, especially for performers without prior technical education.

On his website, O'Connor describes PGJTT as:

a place to learn how to build a JackTrip server with a graphical user interface on an inexpensive Debian-Linux Linode cloud server. The server also provides graphical tools such as QjackCtl26 (for...
audio routing) and the Ardour\textsuperscript{27} DAW (for mixing and recording sessions as well as providing customized monitoring to participants). An inexpensive way to learn and experiment.\textsuperscript{28}

This system can support up to twenty-five participants. Additionally, it includes a monitor mixer delivered through a PureData (Pd) patch.\textsuperscript{29} This allows each musician to tailor their sound experience according to their preferences. The monitor mixer gives multichannel volume control to each performer locally without affecting the group mix.

The performance of the Telematic Ensemble LaFlauta at NowNet 2023 was built upon a series of experiments, rehearsals, and previous virtual concerts conducted by Carrascoza. Since 2020, Carrascoza has utilized a JackTrip image for Linode servers, firstly designed by Bonnie Kwong, enabling her to host various telematic music rehearsals and performances. Notably, in early 2020, Jane Wang and Gloria Damijan, both members of the NowNet Lab Ensemble, led by Sarah Weaver, created a tutorial and instructed the ensemble musicians on setting up a Linode server with a JackTrip image.

In February 2023, Carrascoza began working with O’Connor on installing PGJTT on a Linode server under Carrascoza’s control. They selected a Linode server with a 4GB plan server, in a Freemont region, with 4GB RAM, 2 CPU, 80 GB Storage, 4 TB features, designed to support the Trio Janela performance. Their objective was to establish a system that integrates audio and video broadcasting for the performance of Flying Rivers (2023), a collaborative piece by the trio. This project explores our virtual presence on the screen, as performers are dynamically projected live onto a pre-edited video featuring images related to the natural phenomenon known as flying rivers.

Carrascoza employed a set of tools for the execution of this composition, utilizing JackTrip, PGJTT and Loopback for audio and Zoom along with Open Broadcaster Software (OBS) for video. This work was presented on October 30, 2023 at NowNet Conference 2023.

In July 2023, Carrascoza and O’Connor kept working on installing PGJTT on a Linode server under Carrascoza’s control. They selected a Linode server with a 8GB plan server, in a Freemont region, with 8 GB RAM, 4 CPU, 160 GB Storage, 5 TB features capable of supporting the 10 musicians in our Telematic Ensemble LaFlauta.

The Telematic Ensemble LaFlauta utilized a toolkit to execute their concert demonstration on October 31, 2023 at the NowNet Conference, incorporating JackTrip, PGJTT, Loopback, and Max for audio, along with Zoom as a background tool for video. This system has provided them with high-quality sound. However, there is work still needed to enhance the configuration of Loopback for better integration of the processed sound by Max/MSP in this configuration. The audiovisual system was developed for the Trio Janela performance. In the future, the Ensemble Telematic LaFlauta plans to implement the same system.

\textsuperscript{29} Miller Puckette, \textit{PureData}. V. 0.54-1. MacOS X, Windows, Linux. 2023. Available at: https://puredata.info/.


**Creative Process**

The telematic environment can function as a tool for learning and practicing various aspects of interacting with technology in music. Chagas draws a comparison between the electronic music studio and a model of telematic dialogue:

The electronic music studio can be seen as a model of such a telematic dialog that emerged in the analog era. The paradigm of the electronic music studio is characterized by the systematic exchange of information between different kinds of partners such as composers, performers, engineers, technicians, and listeners using apparatuses for creating musical works.\(^\text{10}\)

Through telematics, we were able to collaborate with students to practice fundamental aspects of sound processing, as the repertoire we created for this project featured a unique Max/MSP patch for each piece. Performer students frequently have limited opportunities to create and develop proficiency in sound processing software like Max/MSP or PureData, as Pino, Smith, and Roth have noted:

Max courses offered at universities often adopt a compositional, project-based approach, asking students to build material in creative and unique ways. Although these projects normally focus on outcomes related to composition or sound design, the practice of live performance with interactive electronics generally is less explored. In these curricula, performers do not get the opportunity to develop and integrate the concepts required to musically interact with technology they are building.\(^\text{31}\)

We initially organized rehearsals with all students, where they practiced together and also collaborated on JackTrip installation and connections. After several rehearsals, we arranged small individual sessions, allowing each musician to experiment with different effects in the Max patch. These rehearsals were an opportunity for them to create new ways of playing and refine their listening to the sound processing.

**Developing the video in the Ribeirão Preto Campus**

As music professors, we consider it essential to encourage our students to learn how to manage audio and video recordings, which includes mastering the basics of editing. We are motivating them to create imaginative telematic performances and explore extended narratives within telematic immersion.

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The students recorded various videos, capturing images of different parts of their bodies up close to the camera lens, intending to be viewed as fragments or isolated body parts. Our aim was to explore the concept of presence in the virtual environment, raising the following questions: How much of ourselves exists beyond our image in video performance? Is it compelling to capture the collective experience in the shared university space? Should the participants be outdoors, indoors, playing instruments, stationary, in motion, engaging in various actions? What does synchronicity mean in music and video? How can we visually express different layers of time?

In the Telematic Ensemble LaFlauta, the participants study at the same school, we noticed that the suggestions for video recordings brought an atmosphere of camaraderie to the group, which was later transferred to the telematic environment. For instance, Bartira Sene, the singer of the group has a disability, and the ensemble prioritized accessibility for her when choosing locations for recording.

Visual Composition: Telematic immersion

The Zoom background tool was employed to project a video during the performance. Nevertheless, not all computers were equipped to utilize this tool. In such cases, we chose a black background to counterbalance the excessive imagery in the video. Some students installed a chroma-key for improved image definition.

The visual elements crafted in this project draw inspiration from the visual research carried out by Chagas and Carrascoza for the composer's immersive telematic works. In the Telematic Ensemble LaFlauta concert, Carrascoza devised a visual composition embracing a non-linear narrative. This composition showcases fragmented images of the performers’ bodies, organized into three sections highlighting eyes, hands, and movement. The images of the performers alternate at different speeds, incorporating repetitions, multiplications, and directional inversions.
An immersive environment was crafted, wherein the edited video images engage in a dialogical relationship with the images of individuals observing themselves on the monitor while playing. These layers of gazes intersect, culminating in an immersive experience for those within the group.

We primarily collaborate within our group using open cameras, observing each other, and consistently watching our reflections on the monitor. Our perception encompasses our physical presence in the space we inhabit, where we simultaneously act as participants, observers, and spectators of ourselves on the virtual stage. This mechanism is described by Ascott as follows:

... the observer in an interactive telematic system is by definition a participator. In a telematic art, meaning is not something created by the artist, distributed through the network, and received by the observer. Meaning is the product of interaction between the observer and the system, the content of which is in a state of flux, of endless change and transformation. In the condition of uncertainty and instability, not simply because of the crisscrossing interactions of users of the network but because content is embodied in data it itself immaterial, it is pure electronic difference, until it has been reconstituted at interface as image, text, or sound.32

The videos are triggered on each computer individually, leading to a lack of synchronization in the images.

Figure 2: Rehearsal of the Telematic Ensemble LaFlauta.

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Compositions

Virtual Studies (2020), by Paulo C. Chagas

Virtual Studies for flute or flute ensemble, electronics and video, with a variable length 6"45" is a cycle of five audiovisual works conceived upon the principle of encouraging the performers’ creative freedom and advancing the use of audiovisual technology in performance. The composition promotes the flexibility of conjugated actions. Each study can be performed independently either in sequence by a single instrumentalist or by an ensemble of flutes. Additionally they can be transposed to other instruments.

As mentioned above, this is the seminal work of the Telematic Ensemble LaFlauta. The piece is dedicated to Cássia Carrascoza, who performed it as a duo with the composer in several telematic concerts in different countries. Virtual Studies has been presented on stage in various concerts and music festivals in Brazil. In the version presented at the NowNet Conference 2023, it was performed by a group consisting of vocals, flute, oboe, violin, mandolin, and guitar, in an authorized version by the composer.

In this composition, Chagas developed the aesthetic concept of a non-synchronous canonic polyphony, exploring the harmonic and timbral potential of melodies, the alternation of sounds and silences, and the latency of the internet, among other elements.

In this work Chagas explains how electronic music explores delay and feedback algorithms to process the sound:

The use of electronic music significantly extends the universe of musical possibilities, from the sounds that extend the timbre possibilities of the flute to the question of temporality that is affected by the extensive use of delay. In other words, electronic music enhances the synchrony and non-synchrony relations in the construction of the work.33

This is a pedagogical work in which the composer envisions freedom in possible versions and encourages the creative work of performers, extending the polyphonic musical thought to the concept of audiovisual polyphony:

Video and audio editing is a creative process of audiovisual composition, which can be performed by the performer or in collaboration with engineers and artists. It is very important to develop a global audiovisual conception of the work exploring the possibilities of composition with sounds and images.34

Chagas conceptualized Virtual Studies as canons ranging from four to seven parts. The performance instructions include suggested guidelines for each study. For instance, Chagas provides the following guidelines for Study #1:

33 Paulo C. Chagas, Virtual Studies: five etudes for flute or flute ensemble, electronics and video, musical score (2020).
34 ibid., iv.
• It can be played by an indeterminate number of flutes, a maximum of seven.
• The score can be transposed octave higher.
• The first flute starts playing the score from the beginning (A)
• The other flutes also begin to play the score from the beginning, but in canon, beginning with the letters B, C, D, E, F, and G.
• The entries for the other flutes do not need to be successive, i.e. each flute can start the canon in any letter.
• The parts can be repeated ad libitum.
• The play can be completed ad libitum; for example, with everyone stopping playing together somewhere; or with each part playing until the end finishing successively.  

To enhance the sound quality with PGJTT, as previously described in this paper, Chagas developed various versions of the Max patch for Telematic Ensemble LaFlauta performance of Virtual Studies at the NowNet Conference 2023.

The following figures show the score corresponding to an excerpt of Study 1 and the Max/MSP patch.

Figure 3: Score excerpt of Study 1 of Virtual Studies by Paulo C. Chagas [13].
Modules 2 - My Words (2023), by Cássia Carrascoza

Modules 2 - My Words is a straightforward musical structure based on the principle of alternating sounds and silences, incorporating the latency of the internet. This composition aims to explore listening and performance in a virtual environment. In working on this piece, we focus on group listening both with and without the Max patch, experimenting with changes in delay and feedback, frequency alterations, and the incorporation of granulated sounds previously inserted into the granulator. For the piece, Carrascoza created her first Max patch, based on Chagas’ patch for Virtual Studies.

The piece consists of 5 parts, called rumos (routes). Figure 5 shows an excerpt from the beginning of the score; Figure 6 shows the corresponding Max/MSP patch. The 5 rumos consist of:

- Proposals for improvisation on expanded techniques with the alternation of short and long sounds;
• Short sounds in sforzato, spaced and alternated as exercises in listening to the sonic environment and the sounds of other musicians;

• Written score constructing a sonic texture based on the Aeolian mode to promote melodic interaction and the perception of musical connection without the suggested synchronicity. This part contains transitional sonic material for the short modules, which are repeated and alternated by the musicians and serve as elements for improvisation.

• Short modules

• Free improvisation with spoken text in its entirety or fragments (excerpt from the "Grande Sertões Veredas" by Guimarães Rosa) over the sound of instruments that gradually dissolve at the end.

**Figure 5**: Score excerpt from *Modules 2, My words*, by Cássia Carrascoza. 

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The piece Textural Studies consists of five modules with improvisation instructions for the musicians. Each module has a specific type of instrumental writing that is related to a type of sound processing. In a way, instrumental writing and electronic processing converge in terms of sound morphology to obtain the final texture that is perceived during the performance. In general, the work exhibits a non-metric tempo, facilitating the interaction between the instrumental ensemble and the live electronic processing performed in the Max/MSP patch. The estimated duration of the piece is nine minutes. Below, we present a brief description of each module.

Module 1 consists of long notes (B in different octaves) from pianississimo to piano, combined with convolution sound processing.

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Module 2 consists of ascending arpeggios of notes belonging to the lower harmonics of the B note series, in accelerando, from piano to mezzo forte. The delay effect is added to the convolution in the electronic processing.

Module 3 consists of two different textures, each of them performed by a subgroup of musicians. The first texture consists of ascending arpeggios in accelerando (as in Module 2) and descending arpeggios in ritardando, with notes equivalent to inharmonic partials in relation to the fundamental frequency (B). The second texture consists of long notes of the B major chord, from p to mp. The electronic processing of this module repeats the delay and convolution of the previous module, with different delay time values.

Module 4 consists of two textures with noisier morphological characteristics. The first texture is a glissando over one octave in tremolo, from mezzoforte to fortissimo. The second texture is a tremolo on a long B note performed with instrumental techniques that highlight noise characteristics in the sound spectrum, such as overpressure in the strings or aeolian notes in the woodwinds, also from mezzo forte to fortissimo. The electronic processing consists of granulation combined with delay.

Module 5 consists of a return to the initial sonority, starting with a B major chord combined with notes corresponding to an inharmonic spectrum of the B harmonic series, in quarter tones. The notes corresponding to the inharmonic partials gradually migrate to the three notes of the B major chord (B, D♯ and F♯). The electronic processing consists of convolution.

The following figures show a score excerpt from Module 3 and the corresponding Max/MSP patch, with modules of convolution, delays and granulation sound processes.

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3. Delay 2 + Convolução
arpejos inarmônicos e microtonais

ord., harmônicos, trilos, multifônicos

Figure 7: Score excerpt of module 3 of Texture studies, by Danilo Rossetti.38

The pedagogical experience was extremely successful, adding to the students' knowledge of interacting with devices such as microphones, interfaces, and cables, as well as learning how to install and operate the JackTrip software on their own Windows computers. Finally, the telematic connections that occur within the ensemble made the students evolve both in terms of performing music together and interacting with real-time processing in different ways.

Conclusions

The utilization of telematic music as a pedagogical tool has demonstrated positive outcomes, contributing to both the acquisition of technological skills and the improvement of musical aspects in collective performances within the virtual environment. The project has promoted the incorporation of technological musical interactivity, encouraging the musical and visual creativity of the students in the Telematic Ensemble LaFlauta. Professors and composers engaged in extensive research on interaction within the virtual environment, exploring technological and artistic solutions to develop new languages. This is a research in progress and the interaction possibilities are not finished.
The notions of connectivity, presence, and time in telematic music induce many possibilities and are part of a panorama of complexity. Each work, within its particularities (instrumentation, electronic processing, video, among other characteristics), follows a unique path and promotes unique connections, levels of presence and musical time. These specific features in telematic music are related to Simondon’s idea of individuation,\textsuperscript{39} in which the processes of transduction and modulation that involve energy exchanges interact, starting from states of metastability with an accumulation of potential energy. The works set these forces in motion and are perceived within a context of virtual reality, in which levels of presence, immersion, and psychological duration occur.

The next stage of this project with Telematic Ensemble LaFlauta involves a new composition for audiovisual telematic immersion, by Paulo C. Chagas and a new composition for solo flute, live electronics, and video by Danilo Rossetti. Chagas’s “Telematic Inventions” project aims to familiarize musicians with electronically mediated performance. This pedagogical project encourages the creation of a work where musicians execute musical parts tied to sound processing techniques and proposes using a series of algorithms accessible on portable platforms. It intends to utilize tools RNBO\textsuperscript{40} a library and toolchain, allowing musicians to work in browsers without specialized software. Carrascoza and Rossetti intend to implement the audiovisual system developed for Trio Janela’s performance in a new musical performance by Telematic Ensemble La Flauta.

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