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Title of the research: From Interpretation to Collaborative Creation - Reframing the Performer's Autonomy in Mixed Music for Cello and Live-Electronics

Artistic Research Question: How can the embodied exploration of Kaija Saariaho's *Près* inform the development of new artistic models for performer autonomy in mixed music with live electronics, from the perspective of the cellist as both interpreter and system operator?

Keywords: mixed-music, live-electronics, cello, interpretation, practice

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Note: Use of AI Tools

During the writing and editing phases of this report, I used OpenAI's ChatGPT as a tool for language revision, editings in structure, and maintaining consistency in tone and terminology. All conceptual content, artistic insights, and critical reflections are entirely my own, developed through independent research and practice.

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1 Abstract

This research investigates the performer's role and autonomy in the interpretation and creation of mixed music with live electronics. The project begins with a multi-layered study of the interpretive process of *Près* (1992) by Kaija Saariaho — from the technical and expressive demands of the cello part, to the development of sensitivity toward the electronic transformations, and the testing of different performative configurations — and evolves toward the co-creation of a new work, *Wolves and Wires* (2025), in collaboration with composer Marta Domingues. In this later phase, the performer actively experiments with the relationship between gesture, sound, and the expressive and technical requirements of the electronic system.

This artistic trajectory, developed across three research cycles, moves from interpretative inquiry to creative authorship. The first two cycles focus on the cellist's practice strategies and technical awareness of real-time electronics, while the third introduces a collaborative process in which the performer contributes to the design of the electronic material, spatial configurations, and control systems.

A defining outcome of this process is the physical repositioning of the performer within the quadraphonic field. In contrast to *Près*, where the performer remains outside the spatial projection, this immersive setup enables full auditory feedback and real-time interaction with the electronics. Spatial integration becomes a condition for performative autonomy, dissolving the separation between acoustic gesture and electronic transformation and allowing the performer to act as a unified sonic agent.

The research reveals that autonomy in mixed music does not arise solely from technological control, but from a situated, embodied relationship with space, instrument, and system. These outcomes contribute to broader reflections on performer agency and offer concrete insights for practice, suggesting new models for collaborative and transdisciplinary creation in mixed music contexts.

2 Introduction

2.1 Motivation and goal

As a music student, I initially believed that the only musical universe that existed was the one I had been taught, which consisted solely of classical music composed long before I was born. However, upon entering university, I began to question this paradigm — not because I encountered radically new musical realities (which I had expected), but because I became aware of contemporary artistic languages in other fields, such as dance and experimental cinema.

In contrast to my experience in music, students in these other disciplines seemed more in touch with contemporary creation. This contrast sparked a desire to explore new aesthetics and musical practices within my own field. As a result, I began to search for new aesthetics and languages in my artistic field and stumbled upon a small elective course at my university dedicated to the exploration and creation of new musical languages, specifically mixed music.[1]

This course proved to be a transformative experience, bringing together instrumentalists, composers, and sound technicians under the guidance of an experienced teacher. It was the first time I experienced a creative process where the instrumental part was not simply delivered to the performer, but developed in dialogue. Rehearsals became spaces of experimentation — not just to refine interpretation, but to shape the material itself. The presence of electronics added a new dimension: we had to negotiate technical setups, signal flow, and spatial projection, alongside phrasing, articulation, and balance. This collaborative, exploratory environment challenged the fixed hierarchies I had been used to and opened up a new set of artistic questions — not only about sound, but about authorship, decision-making, and the role of the performer in shaping the final result. At the same time, I noticed that the technical demands on the cello were not diminished. On the contrary, they were often intensified: extended techniques, micro-gestural control, and precise articulation became essential to activate or blend with the electronic responses.

As I moved deeper into this field, I realised that my engagement with mixed music was shaped by more than aesthetic interest. It also exposed limitations in my training: I had no formal preparation for working with real-time electronics, and few interpretive models or practice resources to draw on. Learning these works often meant navigating extended techniques and non-standard notations without clear pedagogical support. In addition, the electronic layer was usually operated externally and introduced only at the end of the rehearsal process, which prevented me from developing real-time musical interactions with it.

These experiences gradually formed the basis of this research. Could the performer take a more central role in mixed music — one that includes not only technical literacy, but also creative agency? Could a better understanding of the system — including its logic, structure, and affordances — allow the performer

[1] *Mixed music* is a music form that blends acoustic instrumental performance with electronic sound sources, including pre-recorded sounds, live electronics, and computer-generated sounds.

to shape the electronic part in dialogue with their own instrument? And what new artistic models might emerge from this kind of embodied engagement?

To address these questions, I decided to study the first movement of *Près* (1992) by Kaija Saariaho — a foundational work for cello and live electronics. My focus remained on musical interpretation, but I approached the work with the intention of expanding that interpretation across multiple dimensions: sound, gesture, system response, and spatial interaction. The piece was developed during Saariaho's residency at IRCAM[2], in close collaboration with composer and sound engineer Jean-Baptiste Barrière. A co-authored article by the creators[3] documents the compositional and technical development of the piece in detail. This source provides valuable insight into the system architecture of *Près*, and serves as an important foundation for the practice-based approach adopted in this research.

While the first two research cycles are centred on developing an interpretive approach to *Près*, integrating technical fluency and embodied system interaction, the third cycle marks a shift toward collaborative creation. In this phase, I worked with composer Marta Domingues to co-create a new work — *Wolves and Wires* (2025) — that builds on the artistic questions and technical challenges explored earlier. This trajectory, from interpretation to co-authorship, traces a progression toward a model in which the performer actively configures and shapes the musical environment they inhabit.

[2] *Institute for Research and Coordination in Acoustics/Music* (IRCAM) is a French institution dedicated to research and the creation of contemporary music. It was founded in 1969 by composer Pierre Boulez, at the request of Georges Pompidou.
IRCAM has been at the forefront of developing software tools and computer music languages, such as the Max-MSP software (from Ircam).

[3] Xavier Chabot, Kaija Saariaho, and Jean-Baptiste Barrière, "On the Realization of *NoaNoa* and *Près*, Two Pieces for Solo Instruments and IRCAM Signal Processing Workstation," *International Conference on Mathematics and Computing*, 1993.

2.2 Contextualization

This research is situated within the field of mixed music — a domain in which acoustic instruments interact with electronics in performance, often shaped by the artistic vision of the composer. It focuses specifically on works involving real-time electronics, in which the electronic part is processed or triggered live (by the performer). This contrasts with fixed electronics, where audio tracks are pre-recorded and synchronised through a click track. While both approaches are common, fixed setups limit the performer's timing flexibility and musical responsiveness[4]. In real-time systems, by contrast, gesture and timing remain with the performer, who often triggers events directly. Even when pre-designed sounds are used, they are activated by the musician — for example, via footswitches — and integrated as part of the performance. This creates the possibility of a more interactive and responsive performance dynamic.

This difference**,** therefore, is more than a matter of technical choice — it transforms how the performer experiences and interprets the music. In real-time contexts, the performer controls cues and can adapt timing and gesture based on what they hear in the moment of performance. This opens the possibility for an interaction that is closer to chamber music: flexible, embodied, and spatially aware. In this research, real-time electronics are treated not as a separate layer, but as an extension of interpretation — a way to expand musical decisions into sonic, temporal, and spatial dimensions.

The use of electronics in music has evolved significantly over the last century — from Edgard Varèse's vision of "liberated sound"[5] to the emergence of musique concrète and electroacoustic composition. These movements laid the groundwork for what we now call mixed music: the blending of acoustic instruments with signal processing and sound diffusion. Since the 1980s, composers associated with spectral and post-spectral[6] aesthetics — such as Jonathan Harvey (see his article *Spectralism*, written in 2000) or Kaija Saariaho — have used real-time electronics to prolong, modulate, and spatialise instrumental sound. In their work, timbre becomes a compositional material in its own right, shaped through the live interaction between instrument and processing.

There are several composers and performers who have experimented with mixed music, offering extremely important insights. Curtis Roads, a composer and pioneer in computer music, for example, discusses this new aesthetic in his book *Composing Electronic Music*[7], offering valuable insights into the

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[4] McNutt, Elizabeth. "Performing Electroacoustic Music: A Wider View of Interactivity." *Organised Sound* 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X.

[5] Edgard Varèse and Chou Wen-chung, "The Liberation of Sound," *Perspectives of New Music* 5, no. 1 (1966).

[6] *Post-spectralism* refers to a generation of composers who use spectral techniques alongside other musical elements. It is an evolution of the spectralist movement developed by Murail and Grisey, emphasizing the integration of spectral methods into a broader compositional approach. Notable composers include Saariaho, Leuroux or Lindberg. ("Philippe Leroux and the Notion of the Post-Spectral. The Oxford Handbook of Spectral Music | Oxford Academic," accessed May 25, 2023.)

[7] Curtis Roads, *Composing Electronic Music: A New Aesthetic* (New York: Oxford University Press, 2015).

creative and technical aspects of electronic music composition, particularly regarding the use of digital signal processing.

Regarding the performance practice of mixed music, Elizabeth McNutt's article *Performing Electroacoustic Music: A Wider View of Interactivity* (2003)[8] is an important contribution to the discussion on how performers can approach and interact with electronics. McNutt argues that an electroacoustic music performance requires a different kind of interactivity than traditional acoustic music, where performers interact with other performers or with a pre-existing score. She suggests that electroacoustic music requires a more expansive view of interactivity that includes a performer's interaction with technology and the surrounding space, as well as the interaction between the performer and the audience.

Another important contribution is the article *Creative Process and Performance Practice of Interactive Computer Music: A Performer's Tale* (2003) by Mari Kimura[9]. The scholar offers a first-hand account of the creative process and performance practice of interactive computer music, and emphasizes the importance of collaboration between performers and composers in the creation of interactive mixed music, highlighting the need for performers to have a deep understanding of the underlying technology and to be able to improvise in response to the electronic sounds. Kimura also highlights the need for performers to be flexible and adaptable in their performance approach, as the technology and sound environment can vary greatly from one performance to the next. Kimura's insights provide valuable guidance for performers seeking to navigate the complex world of interactive computer music.

Among these various contributions, Kaija Saariaho's work was selected for its particular relevance to the proposed research question. Emerging from the spectral tradition and also connected to IRCAM's research environment, her music explores the intersection of timbre, gesture, and electronic transformation in ways that closely align the electronics with the cello's physical and expressive gestures. Her output for cello spans a range of acoustic and mixed formats, from solo and concerto works to pieces with live-electronics[10]. Notably, *Sept Papillons* (2000) has become one of the most widely performed contemporary works for solo cello. Across the cello works Saariaho has written — with and without electronics — the pieces involving electronics are programmed substantially less often[11], even though they were composed in a similar period and share much of the same musical language and compositional material as her acoustic works. Based on my experience as a performer and through observation of programming trends in academic and professional settings, it appears that this disparity may not be primarily due to the musical language, but rather to the technical barriers, limited training, and unfamiliarity that many cellists face when approaching repertoire with live-electronics.

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[8] McNutt, Elizabeth. "Performing Electroacoustic Music: A Wider View of Interactivity." *Organised Sound* 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X.

[9] Mari Kimura, "Creative Process and Performance Practice of Interactive Computer Music: A Performer's Tale," *Organised Sound* 8, no. 3 (December 2003): 289–296.

[10] From Saariaho's portfolio, on her website: two pieces for cello and electronics and one concerto for cello and electronics; two pieces for solo cello and one concerto for solo cello ("Works - Kaija Saariaho," *Kaija Saariaho*, accessed April 14, 2023, https://saariaho.org/works/.).

[11] Compared from the Wise Music Classic performance's requests of the works of Saariaho ("Wise Music Classical: Kaija Saariaho," *Wise Music Classical*, accessed May 22, 2023, https://www.wisemusicclassical.com/composer/1350/Kaija-Saariaho).

This contrast raises questions about how electronic works are integrated into the performer's artistic ecosystem. When the electronics are conceived as a second instrument with an active compositional voice, but the performer is excluded from understanding or shaping that layer, the result is often a disconnection between the acoustic and digital components. In this research, that system knowledge is not pursued as technical knowledge in isolation, but as a way to expand artistic control. By understanding how microphones, speakers, spatialisation, and cueing shape the outcome, the performer can respond with greater sensitivity and make musical decisions that engage both acoustic and electronic layers. This forms the foundation for a practice in which interpretation is multi-dimensional — expanded through system interaction, but always grounded in musical intent.

2.3 Research question

How can the embodied exploration of Kaija Saariaho's *Près* inform the development of new artistic models for performer autonomy in mixed music with live electronics, from the perspective of the cellist as both interpreter and system operator?

2.4 Specific audiences and readers addressed

This research is directed toward three main groups: instrumentalists working with contemporary repertoire, cellists exploring mixed music, and composers interested in integrating live electronics into their work.

- Contemporary instrumentalists, particularly those new to live electronics, may benefit from the practical strategies explored here — including the integration of extended techniques, interaction with real-time systems, and issues of timing, space, and gesture. The research offers a perspective on how instrumental performance can adapt to and shape electronic environments in rehearsal and performance.

- Cellists will find a detailed case study of *Près* by Kaija Saariaho, approached not only through interpretation but through technical and system-related exploration. The project documents specific bowing techniques, coordination challenges, and the role of spatial listening in achieving a coherent musical result — offering tools to support both individual practice and performance preparation.

- Composers interested in mixed music may find valuable insights into how electronic systems are experienced, negotiated, and embodied by performers. The collaborative creation of *Wolves and Wires* with Marta Domingues serves as a practical example of how dialogue between composer and performer can inform decisions about spatialisation, interface design, and electronic responsiveness. Rather than treating the electronics as a pre-fixed layer, the process foregrounded real-time feedback, gestural flow, and the performer's embodied relationship with sound. This perspective may support composers in designing systems that are not only technically robust, but also musically intuitive and responsive.

3 Research Process

3.1 First research cycle

3.1.1 Overview of first research cycle

In this first research cycle, I chose to investigate a core issue that had emerged clearly through my own experience: my limited familiarity with the operational and interpretative demands of real-time electronics in mixed music. This disconnect — already outlined in the introduction — had often prevented me from developing a meaningful relationship with the electronic layer, reducing my role to that of a reactive player rather than an autonomous interpreter. Within my training context, formal exposure to live-electronics was minimal, and rehearsal time with the system usually came only at the end of the process. These conditions contributed to significant limitations for interpretative depth and artistic interaction.

My goal in this first cycle was to address this gap directly through practice: by learning, testing, and integrating the live-electronic system of *Près* into my own performance process — not as a post-production element, but as a core dimension of interpretation. At the center of this system lies Max-MSP, a real-time visual programming language developed by Cycling '74, which has become a standard tool in contemporary mixed music[12]. In the case of *Près*, it enables a selection of effects, spatialization, and the live triggering of pre-recorded audio files. Understanding how this environment functions — and how it responds to performer input — was an essential first step in developing a more autonomous interpretative approach.

In parallel with this technical exploration, I also focused on specific cello techniques that had emerged as problematic in my reference recording. These included extended bow techniques such as overpressures and contact point's transitions, which Saariaho uses not only as sonic effects, but as expressive parameters fundamental to the piece's identity. The choice of which techniques to develop further was based directly on feedback from my mentors and peers, and the categorization of that feedback is presented later in this chapter.

Once I had engaged both technically and musically with the electronic layer and the instrument-specific demands of the piece, I began to ask: how does this integration shape my musical decisions? Can the electronics influence not only the output, but also the *way* I play — my articulation, tempo, breathing, and phrasing? What happens to interpretation when I am also the system operator? This cycle marked the first stage in rethinking my relationship with the electronics as something interactive, expressive, and artistically integrated.

These questions shaped the structure of the cycle itself: a set of practical experiments, media review, self-critical practice, and gradual refinement — all aimed at reconfiguring my role as a performer within the mixed music environment.

[12] MAX/MSP: A Software Tool for Percussionists - Arizona State University," accessed May 25, 2023.

3.1.2 Reference recording

For this reference recording, I followed the most common approach used when practicing this type of repertoire: becoming familiar with the electronics only in the final phase, due to real technical constraints, and without experiencing them in advance.

I made a conscious effort **to not** study my part in isolation. Instead, I attempted to conceptualize the electronic component through the score, respecting the intended durations and staying aware of the effect triggers throughout the piece. The electronics were added afterwards, using the audio and video of the cello recording. I launched the effects and sound transformations manually within the software.

This required a working knowledge of the piece's Max patch, along with analysis and experimentation with all the real-time effects and pre-programmed event sequences. It was a revealing process, through which I discovered important characteristics that helped shape my understanding of the electronic part.

Reference Recording

- **Kaija Saariaho: *Près*, for cello and live electronics (1992) - excerpt**

- **Recorded in Codarts WMDC, 06-04-2023; Cello: Pedro do Carmo; Electronics: Pedro do Carmo; duration: 2'38"**

3.1.3 Feedback and reflection

After recording the first two minutes of *Près* for cello and live electronics, I collected structured feedback from Jeroen den Herder (main subject teacher), Lluïsa Paredes (a fellow student), and René Uijlenhoet (composition and new media teacher at Codarts). This included external perspectives as well as self-assessment, and a full overview is available in Appendix 3.

The feedback was categorised into three primary areas that would guide the next stage of the research cycle:

1. **Extended bow technique:**

    - The significance of the composers' precise notation on bow technique, in order to convey her musical intentions.

    - To explore different bow techniques, such as a richer and violent *Sul Ponticello* and more scratchy overpressures, to increase the palette of technical possibilities.

    - To experiment with gut strings to achieve greater attention to the contact points between the bow and the string, alongside to improve a different mindset of bow use and practice.

2. **Tempo management:**

    - The importance of maintaining the written tempo and rhythmic proportion for a better musical outcome.

    - The need for better tempo management that alignes with the electronics, for better synchronization.

3. **Integration with electronics:**

    - The significance of the electronic transformation in general and the computer sounds (or events) in particular. It is necessary to get used to them and how they work, so I should experiment and improvise alongside the effects to explore more sound possibilities.

    - The lack of awareness of the duration of each electronic event.

    - The necessity to work with the electronic triggering in real time, for an accurate tempo synchronization between the cello and electronic part and for better music coherence.

3.1.4 Data collection & data analysis: my findings

This stage of the research focused on addressing key limitations that emerged during my early engagement with *Près*, and more broadly from my experiences navigating mixed music as a classically trained performer. These limitations were confirmed by the reference recording and its feedback, and they had also become increasingly evident during the preparatory phase of the project.

Drawing from both personal experience and critical literature — including Bullock et al. (2013)[13], who highlighted the structural absence of live-electronics in formal instrumental training — I identified three main problematics that shaped the practical direction of this first cycle:

1. **Lack of formal training in mixed music performance**
   Despite a growing presence of contemporary music in higher education, mixed music involving real-time electronics remains underrepresented. My own academic training did not provide structured opportunities to interact with these systems, leaving me to rely on self-directed learning and experimentation.

2. **Scarcity of practice resources and interpretive models**
   The limited availability of pedagogical tools — from detailed scores to technical tutorials — made it difficult to establish a clear interpretive foundation, particularly in relation to extended techniques and electronic interaction. This increased the technical challenges of *Près* and highlighted the need for an adaptable, personally constructed method of practice.

3. **Disconnection between performer and system**
   In most performances of mixed music I had experienced or observed, the electronics were managed externally, often introduced late in the rehearsal process. This disconnection limited meaningful interaction and often rendered the electronic part a fixed layer rather than a responsive counterpart. The initial reference recording for this project mirrored this condition: I rehearsed acoustically and only later added the electronics, which significantly impacted the sense of musical integration.

In response to the limitations identified earlier, I structured this section around two core and interdependent dimensions: cello technique and electronics integration. These strands were developed in parallel, not as separate technical tasks, but as interdependent parts of a unified interpretive process. On the one hand, I worked on refining extended techniques such as overpressure and contact point transitions — not as isolated effects, but as expressive tools embedded in the piece's identity. On the other, I worked directly with the Max patch, effect analysis, and spatial output structure — not to become a technician, but to understand how the system behaves in time and space, and how it could be shaped through performance.

[13] Jamie Bullock et al., "Live Electronics in Practice: Approaches to Training Professional Performers," *Organised Sound* 18, no. 2 (August 2013): 170–177.

Dominating Extended bow techniques: Overpressure and Contact Points

While Kaija Saariaho's overall approach to musical notation often leaves room for expressive flexibility — particularly in phrasing, vibrato, and timing[14] — her treatment of bowing gestures and timbral indications is notably precise. In *Près*, these parameters are fully integral to the construction of the expressive material of the piece. This became especially clear in the feedback on my first reference recording, which revealed that I was not fully respecting the detailed instructions related to bow contact points and overpressures — both of which will be defined and developed later on.

Contact Points

Contact Points are specific locations on a string instrument where the bow interacts with the strings to produce different tonal qualities and sound effects. The most common continuum used in notated scores lies between *sul tasto* — bowing over the fingerboard for a soft, airy tone — and *sul ponticello* — bowing near the bridge, producing a more focused, metallic sound. Between these two extremes lie countless nuanced gradations.

In the excerpt of *Près* used for my first reference recording (the first 44 bars), Saariaho notates 45 distinct contact point changes, alternating between *sul tasto* (ST), *sul ponticello* (SP), and *normal* (N)[15].
This number of bow contact indications is quite significant for just 2 minutes and 30 seconds of music. In fact, in my reference recording, I only changed 24 times the contact point, just 53% of what was written. Moreover, the composer specifies that all SP indications should be played "extremely sul ponticello"[16], which basically implies that the resulting sound should be the same as *molto sul ponticello* (MSP). Therefore, the number of contact point changes that I executed correctly is even lower, as there are few moments where I dare to play at MSP level, something that was mentioned several times in the feedback given.

In order to better develop my use of the different contact points in cello playing, I decided to understand these techniques in a more rigorous way. Where does sul tasto end? When does MSP begin? Are these indications always absolute, or do they depend on the musical context in which they are used?

To develop more awareness between different contact points, I recorded a series of contact point exercises, applied through a self-critical, practice-based method. I adapted these exercises from theYouTube channel and website[17] ModernCellist, a platform that provides short tutorials on cello techniques used in contemporary music, made by an experienced cellist in this type of music, Russel Rolen. His videos are characterized by explanatory technique videos, followed by a series of short exercises.

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[14] This insight was shared by cellist Alexis Descharmes during a masterclass at the Impuls Festival (Graz, February 2025), who worked closely with Kaija Saariaho. Although the session was not recorded, the remark concerned Saariaho's openness to interpretive nuance in collaboration with performers.

[15] See all the bow analysis of the excerpt on appendix 5- annotated scores.
[16] From the Composer's Note of *Près* (see the complete text on the full score attached on the appendix 5).
[17] Rolen, Russel. "To the Extremes." *Modern Cellist*. Accessed December 20, 2014. https://web.archive.org/web/20141220214524/http://www.moderncellotechniques.com/bow-techniques/ponticello-tasto/to-the-extremes/.

Quasi-Experiment 1: From ST to SP

To exercise my use of the ST and SP techniques, I decided to record a series of basic exercises for each technique (specifically: slow bow, fast bow, crescendo and diminuendo, different pressures, and a scale). Documenting these exercises allowed me to compare my preconceived tendencies with the actual tendencies I have when playing in different contact points.

Subsequently, I recorded all the steps in the application of bow contact point transition techniques, and it was interesting to find that these techniques are much more challenging to apply than what I thought initially.

- **Step 1: Experimenting Sul Tasto(s)**
  Not so difficult to control after playing the exercises. It's necessary to be cautious about not hitting the cello corners when playing on the A and C strings.[18]

- **Step 2: Experimenting Sul Ponticello(s)**
  More challenging to dominate than what was initially expected. After analyzing the recorded experiments, I noticed difficulties in maintaining consistent bow contact when adding left-hand notes or making string crossings, which are techniques frequently used by Saariaho when playing in sul ponticello.

- **Step 3: Training the Transitions**
  To transition naturally between ST and SP (or, in the case of this piece, MSP), it is possible to predefine the bow angle so that it smoothly and organically moves towards a new contact point during the bowing motion, without needing to force the change within the stroke itself. I experimented with this concept (which I discovered to be less intuitive than I initially thought), precisely determining the angles that the bow could have for different contact points, considering parameters such as the starting and ending points (ST or SP) and the orientation (up or down bow).

In conclusion, this experiment provided valuable insights into the challenges of using different contact points, such as sul tasto and sul ponticello, and transitioning between them.
The exploration of *sul tasto* showed that with practice, it can be controlled effectively to produce desired tonal qualities.

On the other hand, *sul ponticello* presented greater difficulties. Maintaining consistent bow contact while incorporating left-hand or performing string crossings proved more challenging, emphasizing the need for dedicated practice in this technique.

The experiment also revealed that transitioning smoothly between *sul tasto* and *sul ponticello* requires some careful attention. Predefining the bow angle for different contact points proved less intuitive than expected, emphasizing the importance of understanding the desired tonal characteristics and musical context for each bowing.

[18] All the text in italics is adapted from the real-time notes I took while conducting the experiments.

Overpressures

Overpressure is a bow technique, made by applying very hard pressure with the bow on the string. This creates a distorted sound, adding parameters like scratchiness, strangledness, or even subtonal frequencies, depending on the bow position and speed. Overpressure has been used by many composers since the 20th century, such as Penderecki, Crumb, or Lachenmann.

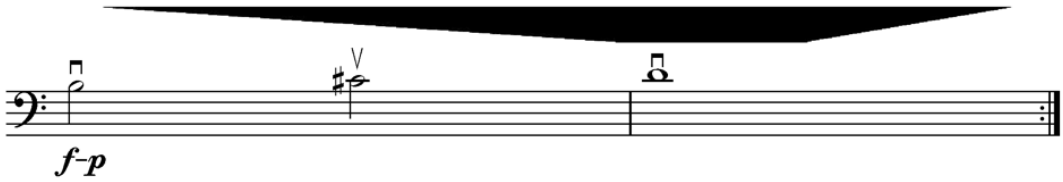
In the previously mentioned excerpt from the piece *Près*, the composer uses this technique only in an area of big crescendo leading up to the climax of the section. There are five overpressures written between measures 36 and 41, the first two being interspersed and the last three in a row, together with an increasing energy on the dynamic (from forte to sforzandos). Given the musical context in which the overpressures are presented, the lack of intensity in the way I play this technique is noticeable, not exaggerating the natural crescendo as much as needed and thus not fulfilling the composer's intention. In other words, my way of playing overpressure is, according to Jeroen den Herder, "too friendly", and does not correspond to the context requirements of the piece.

To overcome what Jeroen den Herder defined as "politeness" in this technique, I studied different exercises for overpressures. Through self-critical practice, I defined the necessary physical criteria for playing different types of overpressure on the cello. I also followed the advice to experiment with this technique on a baroque cello, as recommended in the feedback, due to the similarities in attention and care required for bow technique on gut strings and in contemporary music.

Quasi- Experiment 2: Exploring Overpressures

In order to better systematize the technique, I began by conducting an experiment based on the exercises by the aforementioned cellist, Russel Rolen. On his YouTube channel, he provides a series of eight exercises solely dedicated to the overpressure technique. From these exercises I selected three that I thought would provide a comprehensive overview of the technique, as they encompass various registers of the instrument and incorporate different durations of overpressure. Each exercise is played twice, the first time in forte and the second in piano.

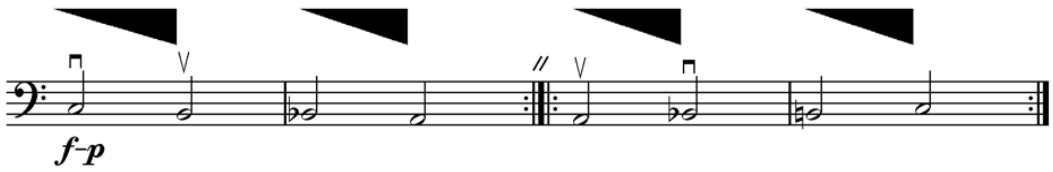
- **Exercise 1-** ***Long and directional overpressure***:
  This exercise embodies the essence of an overpressure, featuring a gradual progression towards a climax and a smooth decay.



When trying this exercise for the first time, I quickly figured out that mastering the overpressure would be more challenging than what I anticipated. I struggled to execute the technique successfully on the first (or second) attempt, particularly when playing forte

with a down bow. It took multiple attempts to grasp the precise influence of parameters such as bow speed, pressure/weight, and contact point (previously studied).

- **Exercise 2- *Abrupt and noncontinuous overpressure*:**
  This exercise aims to train a quick transition between the climax of an overpressure and a normal note.



Initially, I struggled to achieve the desired outcome when attempting to play the overpressure in forte. As described by Prof. Jeroen den Herder, the sound I produced was "too polite." To overcome this counterproductive sound result, I decided to apply an exercise that I had previously practiced in class under the guidance of the same professor: gripping the bow instead of holding it. Playing like this eliminates the nuanced and sensitive gestures that string players employ to obtain different colors from the right hand, leaving only a primal gesture. Given that the overpressure technique yields a rather primal sound outcome, focusing on the core sensation proved to be very beneficial for a good overpressure.

In conclusion, The quasi-experiment provided valuable insights into the nuances and complexities of the overpressure technique. It became evident that mastering the technique requires a deep understanding of the influence of various parameters such as bow speed, pressure, weight, and contact points. The initial challenges faced during the experiment underscored the importance of multiple attempts and dedicated practice to grasp the precise influence of these parameters. Furthermore, the exploration of different exercises shed light on the potential benefits of focusing on core sensations in order to enhance the execution of an effective overpressure.

Quasi-Experiment 3: Overpressures in gut strings

This experience was recommended to me in the feedback received from Jeroen den Herder. According to the professor:

> This type of music has some common aspects with baroque playing, regarding bow use and practice. Modern strings don't require the same care and consciousness for contact points that the gut strings need, although this music is based on that type of attention.

Therefore, I decided to apply the conclusions I discovered in the two previous experiments by repeating the previous overpressure exercises on the Baroque cello. Although these insights could equally have been achieved with a modern setup using gut strings, this alternative setup

provided a useful contrast and reinforced the importance of physical feedback in mastering overpressure.

- ***Overpressures in Gut Strings***

In conclusion, this experiment proved to be particularly useful in understanding the influence of using the parameter of bow speed to achieve overpressure. I intuitively noticed on gut strings that overpressure is much easier to control if, at the same time as the pressure is increased, the bow speed is proportionately reduced.

Tempo management

Regarding the conception and management of tempo in the excerpt of my recording, there were two areas where the composer's indications were not fully developed: the time signature changes and the tempo (or character) indications. By improving my time management to better reflect what is written in the score, it will be possible to create a more organic and coherent integration with the electronic part.

In this cycle, I decided to concentrate on the first of these — the notated time signatures — as they posed a concrete obstacle to achieving rhythmic clarity and synchronicity with the electronic part. The question of tempo character will be explored in a future cycle, where it can be examined alongside phrasing and expressive timing in a more integrated context.

The issue of time signature changes

In the first 41 bars of *Près*, Saariaho changes the time signature 32 times. These changes do not always correspond to shifts in tempo or expressive character — rather, they often reflect the composer’s desire to notate subdivisions precisely, particularly as the material alternates between binary and ternary groupings.

For a performer, however, the sheer frequency of these changes can introduce some complexity. Even when the pulse remains stable, the need to readjust the metrical frame bar by bar can disrupt the internal sense of flow. This is especially challenging when the performer, as in my case, does not have extensive experience with this type of rhythmic notation.

My main difficulty was not with tempo fluctuations per se, but with maintaining a consistent rhythmic proportion while rapidly shifting between different metric groupings. How could I study this efficiently, while developing a feel for the larger phrasing — beyond the bar lines?

The practice solution: Click Tracker

While studying this piece, I felt the need for a metronome that could follow all the changes in time signature and tempo in real-time, in order to study the musical flow throughout the changes. I realized that the best way to overcome the issues mentioned would be to use a click-track.[19]

After some research, I found the *Click-Tracker*, a simple way to create a click-track that follows the specific time signature changes and different tempo changes in this piece, as well as the ability to slow down the tempo for practice without changing the rhythmic proportions.

The *Click Tracker* is a tool created by the composer João Pais[20]. It is an application developed using Max-MSP software, allowing the creation of a customized click-track through accessible programming. It is the simplest click-track generator I have found, all that is required is to transcribe the tempo and time signature indications from the score into a plain-text file, which is then loaded into the *Click Tracker* application. Some illustrative examples:

- **Example 1- *Screenshot of the .txt file***
- **Example 2- *The file uploaded to the click tracker application***
- **Example 3**- ***Excerpt of the click track (audio file)***

It is important to note that the use of a click track is not, in the long-term study, compatible with this piece. The composition contains several fermatas and sections of interaction with the electronics that also affect the perception of time. These cues cannot be simulated with a click track. Its function is only the same as that of a metronome in the individual study of a piece.

[19] "Click track" is a term used in music production and recording to refer to a rhythmic guide that provides a constant audible reference for musicians to play along with. It typically consists of a metronome-like sound, such as a series of clicks or an electronic drum beat, and is used to ensure that all instruments and vocal performances are in sync with each other. Click tracks are often used in genres such as pop, or and electronic dance music, where precise timing and tempo are important. ("Click Tracks," *MM Productions*, accessed March 31, 2008)

[20] João Pais (b. 1976, Lisbon) studied composition and electronic music in Lisbon, London, and Freiburg, attending seminars by Emmanuel Nunes and Salvatore Sciarrino. He created and directed the new music festival 'Jornadas Nova Música' in Aveiro and developed the improvisation project Endphase. Pais created the Click Tracker software. He works as a musical engraver for publishers such as Wilhelm Hansen and Chester Music (based on João Pais online bio).

Context and Analysis of the Electronics of *Près*

The creation context of *Près*

Kaija Saariaho is a composer known for her sobriety and clarity in the use of electronics in her works of mixed music, often employing it as an extension or contour of the sonic idea presented by acoustic instruments.[21]

In 1992, Saariaho was working at IRCAM - Institute for Research and Coordination in Acoustics/Music. At the time, her focus of study was the use of timbre, specifically "timbre as an extension of acoustical instruments and as a globalization of sonic phenomena," and the search for a "timbral space"[22]. This led to the need for utilizing sound synthesis, where her interest in the relationships between timbre and harmony allowed for the unification of instrumental and electronic writing on her works.

In collaboration with Xavier Chabot and Jean-Baptiste Barrière, Saariaho developed two mixed music pieces that year: the aforementioned *Près* (for cello and live electronics) and *NoaNoa* (for flute and live electronics).

For reporting the working process, the three agents wrote together an article titled *On the Realization of NoaNoa and Près, Two Pieces for Solo Instruments and Ircam Signal Processing Workstation*. This article provides a detailed description of the entire creative process and formal specifications of the two works, serving as one of the primary sources for this investigation. A summary of my analysis of the article is presented in the next section.

Analysis of the electronic part of *Près:* from primary source

In the creation of the electronic part of *Près*, the sound world originally grew out of sampled material from a series of studio experiments that the composer conducted with Anssi Karttunen. For these tests, Karttunen's cello was equipped with a special prototype microphone developed specifically for the project, consisting of four independent pickups that isolated the audio signals of the four strings from one another. This setup allowed a single bow stroke to become a spatial gesture in the electronic domain. Although the samples used in the final electronic part were not recorded with this microphone, it nonetheless played an important role in the compositional process of the piece.[23]

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[21] Saariaho, Kaija. "Using the Computer in a Search for New Aspects of Timbre Organisation and Composition." *International Conference on Mathematics and Computing* (1983).

[22] Chabot, Xavier, Kaija Saariaho and Jean-Baptiste Barrière. "On the Realization of NoaNoa and Près, Two Pieces for Solo Instruments and Ircam Signal Processing Workstation." *International Conference on Mathematics and Computing* (1993).

[23] This information is not documented in the technical report by Chabot, Xavier and Saariaho. It is based on insights shared by Anssi Karttunen in a workshop during the Darmstadt Summer Courses of 2025, where he described the prototype microphone as a device designed to track, string by string, the harmonic content of the cello and use it as control data for the live-electronic processes (in particular pitch-shift).

The electronics of the first section of the piece are based on the digital spectral analysis of the first note, a 6th harmonic trill in the 4th string (E flat). The trill alternates between normal sound and natural harmonic sound, progressing from playing *sul tasto* to *sul ponticello*. From these analyses, two spectra are derived: a complete spectrum with all components and a reduced spectrum that retains only perceptually relevant components after frequency masking[24]. Synthesizing the complete spectrum produces unique timbres, while synthesizing the reduced spectrum generates a set of pitches perceived as harmony. This analysis of the trill serves as a central element in defining the movement between harmonic relaxation and tension and establishing coherence between the instrumental and synthetic sounds in the piece.

In addition to the exploration of timbre and harmony, *Près* incorporates various transformation processes that run concurrently with this duality. The cello part undergoes a lot of transformations in playing techniques, such as transitions between contact points, trills, tremolos, glissandos, use of microtones, harmonics, and the transformation of sound into noise through the overpressure technique. These transformations are mirrored in the electronic part. Rhythmic processes and the interplay between static and dynamic elements further contribute to the sonic evolution. The cello part's pseudo-regular and repetitive patterns spread across the four strings and overlap with the different extended techniques and sound transformations. The electronic part, based on the sampled cello experiments mentioned above, can interpolate between sounds with varying levels of harmonics. It is controlled by independent processes for rhythm and timbre variation, resulting in a dense polyrhythmic texture when combined with the live cello performance. The contrast between pure and noisy elements is introduced abruptly in the cello part and amplified in the electronics through the playback of a cluster sound and the activation of a real-time time-stretching module.

Integration of the Electronics

Playing pieces with live electronics is a task that always involves a great deal of adaptation work, as one of the necessary conditions for this type of music is the "prosthetic elements"[25] it imposes on the acoustic performer, from physical limitations (awareness of different microphones or the use of pedals) to sound constraints, such as the necessary adjustment to the instrument’s amplification and the entire process of knowing and interacting with the electronic part.

In this research cycle, I will only focus on the discovery process of the electronic part and its musical interaction through the use of a foot pedal, leaving the topics of amplification, relationship with the speakers, and spatialization in the hall for future research cycles.

[24] Frequency masking is a phenomenon in which a sound becomes inaudible or less audible when another sound of higher intensity and similar frequency is present. Frequency masking is used in sound synthesis to create complex timbres and reduce aliasing artifacts. - Moore, B. C. J. (2012). “An introduction to the psychology of hearing” (6th ed.). *Emerald Group Publishing*. Roads, C. (1996). “The computer music tutorial”. *MIT Press*.

[25] McNutt, Elizabeth. “Performing Electroacoustic Music: A Wider View of Interactivity.” Organised Sound 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X

Playing with live-electronics: literature research

After reviewing various sources, certain themes stood out more than others, emphasizing the challenges, considerations, and collaborations involved in integrating technology into live performances.
One of the main stands out is the complexity of the relationship between instrumentalists and live electronics.

In the article "Instrumentalists on Solo Works with Live Electronics - Towards a Contemporary Form of Chamber Music?" by François-Xavier Féron and Guillaume Boutard, it is emphasized that this type of music should be considered as chamber music. They argue that solo works with live electronics should be worked and practiced as part of the chamber music repertoire by the performers, despite the differences in interaction. The traditional forms of human interaction such as physical cues, eye contact, and breathing together are not possible in this context. “Sound becomes the primary measure of correlation”, says Elizabeth McNutt,[26] a classical flutist, experienced in contemporary and electroacoustic music.

Another theme explored is the challenges posed by the incorporation of electronic elements into traditional performance settings. McNutt addresses the "prosthetic elements" introduced by electronic devices, such as microphones and loudspeakers, which can complicate the performer's regular music production. The use of loudspeakers, in particular, creates a disconnect between the performer, the space, and the sound source. Performers accustomed to physically adapting to the acoustics of the room face the contrast of imagining music within the fixed and artificial space of loudspeaker diffusion. McNutt highlights the importance of collaboration and effective communication between performers and sound engineers to overcome these challenges, and also how the use of the footswitch can empower the performers freedom.

However, these opinions on the relationship with technology are not unanimous. Mari Kimura, a well known violinist with a career in modern music, emphasizes the need for simplicity, coherence, and independence in the integration of technology into live performances. She argues against the use of foot pedals, favoring a "one-touch" system that minimizes direct computer interaction. Kimura assumes both the roles of performer and interpreter to align the computer's behavior with her own timing and intentions, being against the use of a sound technician: “I am also against having a second person controlling the computer while I am playing.(…) The second person simply fills in a technical function whose only r*aison d’être* is the lack of built-in automatic coordination between the live performer and the computer.”[27]
She highlights the importance of maintaining a strong connection with the audience and avoiding unnecessary distractions. Kimura's solutions, such as the use of a Flexible Time Window, showcase her meticulous attention to detail and her commitment to robustness in performances.

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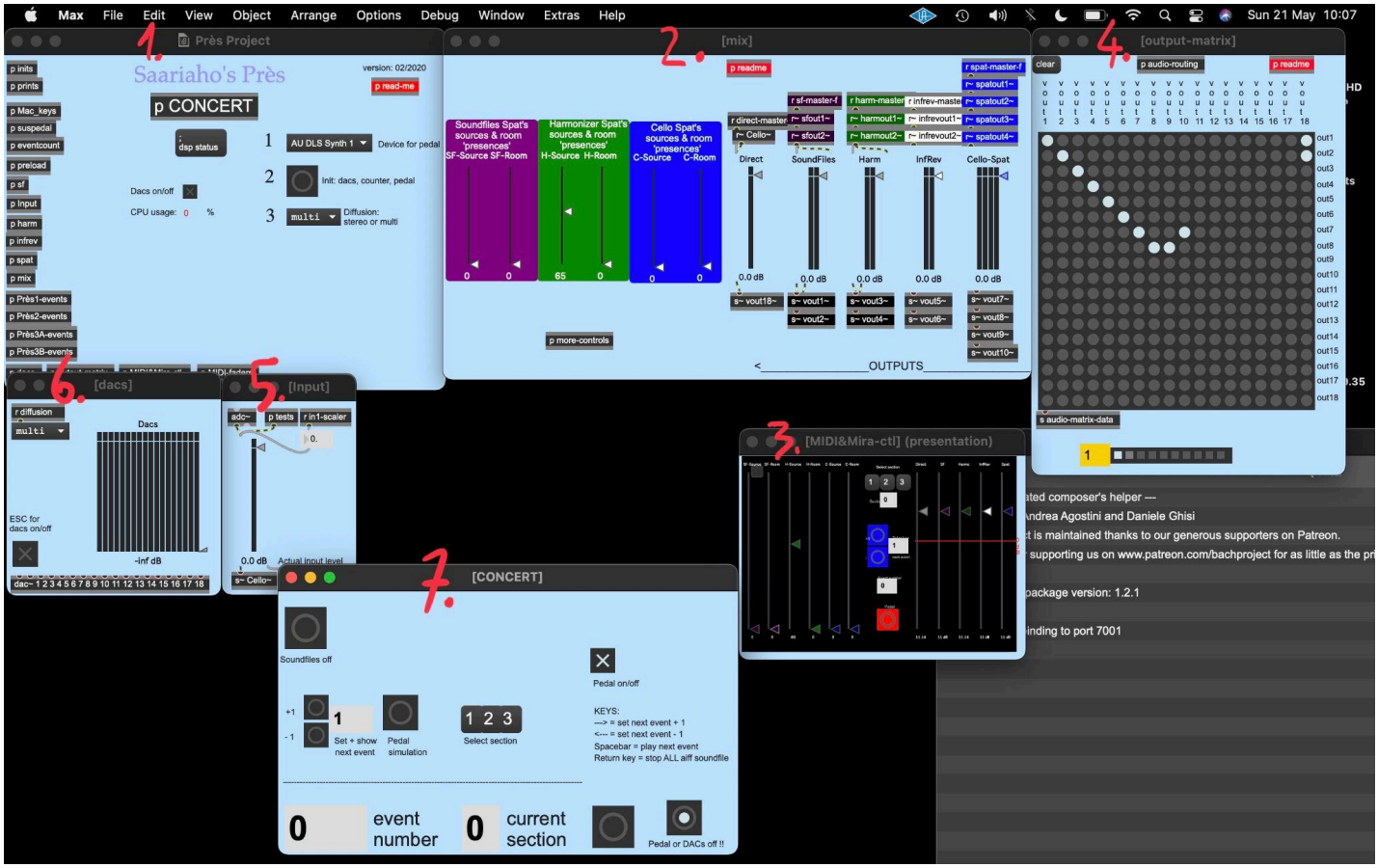
[26] McNutt, Elizabeth. “Performing Electroacoustic Music: A Wider View of Interactivity.” *Organised Sound* 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X

[27] Kimura, Mari. “Creative Process and Performance Practice of Interactive Computer Music: A Performer’s Tale.” *Organised Sound* 8, no. 3 (December 2003): 289-296. doi:10.1017/S1355771803000268.

Knowing the Max-patch of *Près*

The Max-patch was developed and is constantly updated by the composer and sound engineer Jean-Baptiste Barrière. The composer was a resident technician at IRCAM in 1992, closely following the compositional process of this piece with composer Kaija Saariaho and was responsible for the original technical realization of the electronic part of this piece.
Upon opening the downloaded file in the Max-MSP application (version 8), the 7 user- interactive windows of the patch appear, each addressing various important technical issues:[28]



1. The main window, *Près Project*, serves as a menu, providing on/off buttons for the entire system and audio output. It also lists shortcuts to sub-patches (on the left) containing the raw programming of the patch, allowing for access for adjustment in the code if needed. This requires expertise in the Max-MSP language.

2. The *Mix* window functions as a digital mixing console, enabling control over various parameters. It includes sound effects such as reverb, footswitch-triggered events, and a harmonizer. Each effect has an intensity fader for precise control. Additionally, there are volume faders for direct cello

[28] Please see the complete analysis of the patch on appendix 5 (analysis- full analysis of the max-patch).

amplification. This section acts as a basic mixing console for overall volume adjustments, with Barrière recommending adjustments according to the acoustics of each performance space.

3. The *MIDI & Mira controls* window offers a shortcut mirror controller for physically controlling the mixer faders using a MIDI device or to connect an iPad via wifi (optional).

4. The *Output Matrix* window allows users to map the number of outputs based on the available speakers in the concert hall or rehearsal space. The patch supports a range of speaker configurations, with an emphasis on spatialization to create an immersive listening experience. The distribution of parameters in space dynamically responds to factors like intensity, dynamics, and the activated events, creating an engaging acoustic sensation.

5. The *Input* window provides control over the analog volume level of the cello microphone.

6. The *Dacs* section handles the conversion of the digital signals of the processed sound into analogue signals that go to the selected number of outputs (or loudspeakers).

7. The *CONCERT* window facilitates the monitoring of remotely activated events via a cellist's pedal. It also allows for rehearsal situations, enabling specific sections with electronics to be rehearsed without going through the entire sequence of events. Additionally, it provides event monitoring when triggered by someone at the computer, with the option to launch events using the spacebar instead of the footswitch.

Quasi-Experiment 4: the Output Matrix

According to Barrière's notes[29],the piece is meant to be played with four speakers at least (two in the front and two in the back), being the optimized performance setup between 8 and 18 loudspeakers.
The high number of speakers for the ideal performance is because the entire patch is spatialized. In other words, the different sound parameters of the electronics (infinite reverb, harmonizer, trigger of events) are distributed across the different speakers throughout the piece, creating a fully immersive atmosphere for the listener.
The distribution of parameters in space changes according to various factors such as intensity of the cellist, dynamics, sound spectrum, type of activated event, etc., conveying an actively rich acoustic sensation, almost like a living organism that reacts in real-time to the cellist and the space.
These acoustic possibilities of the relationship between timbre and space are Saariaho's main focus of study at this time, and for me they represent the ultimate artistic possibilities of real-time electronics in this piece.
To better understand the sonic differences between each output, I started by identifying those responsible for the distribution of continuous reverb diffusion (out of 18, only 5 produce sound, with the last one serving only as amplification), creating a constant texture throughout the first movement. Then, I explored the sonic possibilities of each output by isolating one for each take in this experiment. In the end, I recorded a short improvisation with all the outputs simultaneously, on the harmonizer and the reverb.

[29] Please see the complete analysis of the patch on appendix 5 (analysis- full analysis of the max-patch).

1. ***Output Cataloging***
2. ***Isolated Outputs***
3. ***Experimenting with full outputs***

In conclusion, I was able to gain a deeper understanding of the musical potential of the electronic sound effects in the piece through this experiment. By testing and freely interacting with the sound effects, as recommended in the received feedback, I was able to perceive the influence of electronics on real-time instrumental practice. From take to take, it became evident that the pursuit of fusion with the electronic elements prompted me to modify certain parameters of my performance, such as tempo, dynamics, or contact point.

Event Triggering: Including the footswitch

This patch was designed so that the cellist on stage can activate the succession of events through a MIDI [30] footswitch. However, connecting a footswitch via MIDI requires a larger (and expensive) technical setup, which was the only possibility in the 90s. Nowadays, with numerous connectivity technologies available, it is possible to find more practical solutions to connect a foot pedal, such as a Bluetooth page turner.
However, in order to connect my Bluetooth pedal into the max patch, it was necessary to modify the programming since the patch was not made to receive a Bluetooth pedal. This involved online research on how to make the patch recognize it.

- **Finding my pedal**

  A Bluetooth pedal, I came to discover, functions like a Bluetooth keyboard, usually corresponding to certain keys on the keyboard. This is how Max recognizes the pedal, as a keyboard. For the software, each key corresponds to a number (the ASCII[31] value- on example 1) , which can then be associated with a function (such as triggering an event: Whenever the number X appears, Max knows to move to the next event).
  One question arose: Which keyboard keys do the buttons on my pedal correspond to? Each pedal is different, and this information is not available on the manufacturer's website. After some trial and error, I found out that Max itself has a patch to detect the key, concluding that the pedal buttons are keys 30 and 31 (up and down arrow).

  - **Example 1: *Explanatory key-patch***

[30] MIDI (Musical Instrument Digital Interface) is a standard protocol for communicating musical information between electronic musical instruments, computers, and other MIDI devices. It allows for the transmission of performance data, such as note pitches, durations, control changes, and synchronization, facilitating interoperability and control in music production and performance (“MIDI - Wikipedia,” accessed May 25, 2023).
[31] The ASCII (American Standard Code for Information Interchange) is a numerical representation of a character in the ASCII character set. Each character in the ASCII set is assigned a unique value ranging from 0 to 127. This value corresponds to the character's binary representation, which allows computers to interpret and manipulate text.
(Britannica, T. Editors of Encyclopaedia. "ASCII." *Encyclopedia Britannica*, April 11, 2022. https://www.britannica.com/topic/ASCII.)

Next, it was a matter of locating the event activation zone through the space bar in Barrière's patch (having the spacebar connected is a proforma in this type of work), so that I could also integrate the key number I just discovered to that same function. It worked.

- **Example 2**: ***Playing with Bluetooth Pedal for the first time***

In conclusion: Learning this process was essential in this experience, something that will allow me to connect my pedal to any Max patch. One of the obstacles to practicing this music is the lack of technical support compatible with MIDI pedals nowadays, and this procedure should be included in today's patches. With the proliferation of Bluetooth pedals, having the possibility to connect them easily to a patch would also be an incentive for practicing this type of music.

3.1.5 Interventions / practical application

The experiences I conducted throughout the previous data collection, triangulated with the discovery of the described practice tools and the selected literature review, unquestionably deepened my understanding of the work *Près*.

By exploring key dimensions of the piece- such as the use of extensive bow techniques, time management, and integration with electronics- I was able to gain a better knowledge of composer Kaija Saariaho's creative and composition process. From the meticulously notated bow techniques to the sensitivity of each output in the electronic patch, I began to identify the focal points developed by the composer, namely the relationship between timbre, harmony, and space. This understanding grew stronger through the multiple experiences of this research cycle, especially when I immersed myself directly within the patch.

On a practical level, the experiences I conducted not only made me aware of musical and technical inconsistencies in my reference recording but also presented possible solutions to these problems. Therefore, I decided to better consider the following aspects in my future interpretation:

1. **Increased awareness of bow contact points**

   During quasi-experiment 1, I understood the musical richness of different contact points and their real importance in conveying a timbral message, which is an important topic for the composer when creating this piece. I have decided to dedicate study time to all the indicated changes in bow contact points noted by the composer in the referenced excerpt.

2. **Emphasizing overpressures**

   The five overpressures (between bars 37-41[32]) present in this excerpt did not catch my attention when I recorded the reference recording. It was only after conducting the experiment that I conceptualized what an overpressure really is and what are its technical requirements. In future interpretations of the work, I will apply the knowledge I have gained, giving importance to the overpressure technique as emphasized by the composer in those specific moments.

3. **Improving electronic integration: Bluetooth pedal and real-time feedback**

   In my initial approach to *Près*, the electronics were applied after the cello part had been recorded — a process that mirrored a pattern I have encountered in several mixed music projects. In these contexts, the electronics were often managed by an external technician, introduced only in the final rehearsals, with limited time for adjustments and the creation of refined musical interactions.

   I was aware that this process would have musical disadvantages, but I wanted to document them to highlight that this "applying" of electronics is highly unmusical. However, the consequences became more evident than expected, particularly in terms of time management. As a result, I

[32] Please see all the bow techniques analysis of the excerpt on appendix 5- annotated scores.

have decided to use a Bluetooth pedal for self-triggering the electronic events. This self-triggering requires dedicated practice of its physical aspects added to the playing[33]. Additionally, I have chosen to extensively study the piece with real-time electronic feedback using monitor earphones. This allows me to hear the reverb produced alongside my own sound, enabling better adjustment and understanding of the musical atmosphere that is being created.

4. **Establishing the mapping of the electronics**

Regarding the electronic part, this research cycle has proven to be truly important for my knowledge. Getting technically introduced to the concept of spatialization through the different outputs and knowing its significance to the composer has become an aspect to consider in my interpretation.
The electronics in this piece serve to enhance expressivity. However, if the balance is not properly regulated, their influence can compromise the entire musical result. The small experiments I conducted with Barière's patch have helped me understand the importance of adjusting the levels of the sound effects, events, and cello amplification. These three sound sources must be balanced to achieve organic fusion while preserving rich detail in each component. This balance is highly dependent on the room and equipment context. Therefore, it is crucial to experience the room and equipment through proper testing until the balance - which I referenced during quasi-experiment 4- is obtained.

3.1.6 Outcomes

The outcomes of this first cycle are reflected in a broader general knowledge of the technique necessary for the overall functioning of the piece, both at the cello level (through the exploration of the most commonly used extended techniques) and at the electronic part level (by understanding the Max-MSP patch).

The previous definition of the intervention points allowed me to explore the musical and technical pillars of the work, enabling me to understand the sound and musical goals of the piece *Près* for the composer Kaija Saariaho[34].

The previously mentioned parameters were applied in the next reference recording:

Reference Recording 02

- **Kaija Saariaho: *Près*, for cello and live electronics (1992)- excerpt**

[33] McNutt, Elizabeth. "Performing Electroacoustic Music: A Wider View of Interactivity." *Organised Sound* 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X

[34] ***Note:*** The composer Kaija Saariaho passed away while I was revising this section, on June 2, 2023, at the age of 70. I pay tribute here to the tremendous musical creation carried out by Saariaho, expressing gratitude for her dedication to new music and musical experimentation, particularly in the field of mixed music with real-time electronics. The present piece of this research, *Près*, is one of the many works by the composer that developed this musical aesthetic, leaving a lasting impact on all contemporary musical creation today and a legacy for future generations of composers and performers.

- **Recorded in Codarts WMDC studios, 05-06-2023; Cello and live-electronics: Pedro Carmo; duration: 2’22”**

- **Disclaimer:** The low video resolution is an inevitable compromise to prioritize the audio quality of the electronic part. If an external camera were used for recording, the electronics would have to be played through loudspeakers and then recorded by microphones, resulting in a huge loss of the original sound quality. By internally recording in Max-MSP (simultaneously with a webcam for perfect synchronization), it is possible to achieve superior audio quality and an accurate video reference, which is the primary focus of this work.

3.1.7 Feedback, reflection and conclusion

This recording, musically speaking, demonstrates a greater attention to the timings between the cello and electronics, as well as a heightened focus on creating different atmospheres for each musical gesture, both at the cello level (with a greater musical integration of the contact points) and at the electronic level (respecting their decays of the reverb and the sequence of new events).
In the end, it embodies a version of the different timbral landscapes of the piece, achieved through an understanding of the relationship between the cello and the electronics in the composition. It is possible to perceive not two separate factors interacting musically, but rather a unified, organic, and fluid sonic entity.

This unified sonic entity reflects a resignification of performance, where the cellist is no longer positioned as a mediator between two systems, but rather as the core agent of an integrated musical environment. In this context, the performer assumes a dual role — both as instrumentalist and system operator — shaping the electronic layer not as an external component but as a co-authored extension of the final sound, shaped in real time. This perspective challenges traditional notions of interpretation in mixed music and proposes a shift in how the performer perceives their own agency within the performance of this music. The artistic possibilities opened by this approach will be further explored in the next research cycles, as this evolving role continues to be shaped and redefined through practice.

3.2 Second research cycle

3.2.1 Overview of the second research cycle

The first research cycle focused on developing the technical skills required to perform *Près* by Kaija Saariaho, with particular emphasis on cello technique and the integration of live electronics through system knowledge and practice. Having addressed these foundational aspects, the second cycle shifts the focus to the act of performance itself: how musical and technological elements interact in real-time, and how the performance environment contributes to this interaction.

The performance characteristics of mixed music include some peculiarities. The relationship with the space where the performance takes place[35] (where space is often one of the artistic parameters in composition) and the presence of an "active composer" (or electroacoustic performer) responsible for the electronics are recurring factors that should be of significant consideration for the performer.[36] Both themes are essential to the performance practice of mixed music and had not yet been directly investigated in this research. Each is examined independently — through practical experiments, rehearsal documentation, and selected literature — and the insights developed across both are brought together in the final performance of this cycle.

This second cycle also marks a shift in my approach to *Près*. For the first time, I performed the piece with another person managing the electronics in real time. This collaborative setup echoed the original conception of *Près*, developed in partnership between Saariaho and Barrière, with cellist Anssi Karttunen. Comparing solo and collaborative performances provided a valuable opportunity to reflect on the evolving roles of performers in mixed music, and on the artistic potential of shared control in live performance.

[35] Saariaho, Kaija. "Using the Computer in a Search for New Aspects of Timbre Organisation and Composition." *International Conference on Mathematics and Computing* (1983).
[36] McNutt, Elizabeth. "Performing Electroacoustic Music: A Wider View of Interactivity." *Organised Sound* 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X

3.2.2 Reference recording

The Reference Recording for this cycle is a live performance of the first movement of the piece “Près” by Kaija Saariaho, framed within a lecture I gave at the *Zutphen Cello Festival 23* on my Artistic Research project. It was chosen precisely because it is a performance, enabling the analysis to focus on the key performance characteristics of mixed music mentioned earlier.

Reference Recording

- **Kaija Saariaho: *Près*, for cello and live electronics (1992)- 1st movement**

- **Recorded in *DatBolwerck*, Zutphen Cello Festival; 24-08-2023; Cello: Pedro do Carmo; Electronics: Pedro do Carmo; duration: 7’15”**

3.2.3 Feedback and reflection

In the previous recording, I was able to observe that the topics requiring further reflection are no longer related to instrumental mastery and knowledge of the electronic components (both themes addressed during the previous cycle), but rather concern the sonic fusion between the two elements (cello and electronics) during the moment of the performance and how it relates to its surroundings.
After asking for feedback on this recording from my colleague Lluïsa Paredes, Portuguese composer Eva Aguilar, and taking into account the interview I conducted with René Uijlenhoet (A complete overview of the feedback is in Appendix 3, including my own reflection), I decided to focus on two important performance characteristics of mixed music that have not yet been addressed in this research:

1. Relationship with the Electronic Performer

The piece *Près*, despite officially allowing (and even encouraging) the cellist to handle the electronics[37], was initially conceived in a collaborative composition paradigm — meaning, the performer has a certain influence in the creative process, and the composer plays a role in the performance of the piece. The patch for *Près* was designed so that Kaija Saariaho (electroacoustic performer) could adjust the live electronics while Anssi Kartunnen played the cello part, bringing a unique richness to each performance (this topic will be further developed in the data collection).

Up until the presentation where I recorded the Reference Recording for this cycle, all the performances I did of the piece were always solo, with me also responsible for the electronics. Despite being possible for both functions to be handled by the instrumentalist, I thought it would be interesting to compare a collaborative performance with a solo performance. I challenged composer Eva Aguilar to play the electronic part for the piece *Près* for a concert at the International Chamber Music Festival of Lisbon in September 2023. The documentation and description of the rehearsals, as well as the recording of the performance, are developed in data collection and interventions.

2. Relationship with space as a compositional element

The use of space in contemporary music is challenging to describe, given that the definition of "space" can encompass a multitude of different concepts depending on the context, field of study, or perspective. However, the relationship between space and time - acknowledging that time occurs in space - is a common thread in various definitions[38].

This serves as the starting point for numerous composers who, throughout the 20th century, explored diverse uses of space in their music. This exploration is commonly referred to as **spatialization**. Similar to space, spatialization is not an easily defined concept. According to the ElectroAcoustic Resource Site (EARS):

> Spatialization is perhaps the most all-embracing and general term used to describe the means by which loudspeakers are used to articulate or create a spatial musical experience for listeners in playback or

[37] See the Max-patch's transcript and analysis on Appendix 5.
[38] Trochimczyk, Maja. 1994. "*Space and spatialization in contemporary music : history and analysis, ideas and implementations.*" Thesis, Schulich School of Music. McGill University.

performance. The term is wide-ranging from a technical, and arguably aesthetic point of view. It includes formats (e.g. Stereophonic, Ambisonic, Dolby), the placement and movement of sounds in space in any number of listening situations (e.g. concert hall, installation, virtual environment, cinema), and performance practices (e.g. diffusion, Octophony, and more recent developments in automated performance systems)[39].

[39] From: *ElectroAcoustic Resource Site (EARS). Spatialization:* http://ears.huma-num.fr/3495f1f3-718b-42df-a1dd-8549e754f974.html. Accessed on 15-11-23.

3.2.4 Data collection & data analysis: my findings

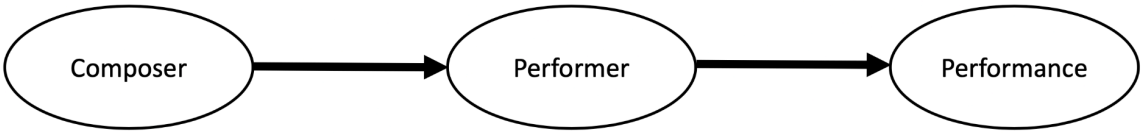
3.2.4.1 The Electroacoustic Performer

Literature Review: Contextualization

To better understand the function of the electroacoustic performer, it's necessary to know that mixed music represents a pronounced shift in paradigm concerning composition, interpretation, and performance compared to previous musical practices. This genre significantly alters the "composer-performer" circuit described by Pierre Boulez as follows:

> *A. The composer creates a ciphered structure.*
> *B. They encode this structure into a coded plot.*
> *C. The performer deciphers this coded plot.*
> *D. According to this decoding, they restore the structure transmitted to them.*[40]

This circuit can be summarized in the following diagram, described by the clarinetist Nuno Pinto[41]:



These three dimensions (composer-performer-performance) act in a unidirectional and independent manner. Firstly, the work itself, which is entirely independent of the interpretation and the space/context in which it is presented. Secondly, there is the interpretation, where the performer prepares the score individually and strives to defend the work to the fullest during the performance, even if they are acquainted or have collaborated with the composer. Lastly, the performance itself is nothing more than the transmission of an ideal work but will always include the imperfections inherent in a live performance.

Until the end of the 20th century, this was the dominant compositional paradigm in contemporary music. It was precisely at the turn of the 21st century that several works began to emerge, where the dimensions of "composer-performer-performance" ceased to be separate worlds and became interdependent dimensions, relating and interacting throughout all stages of the process[42].
These new relationships can be identified in the following diagram:

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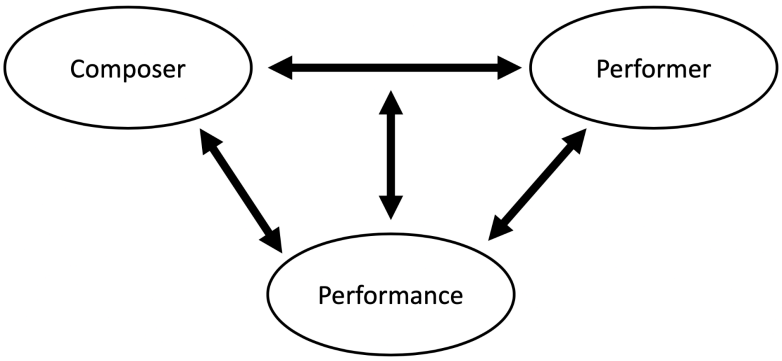
[40] Boulez, Pierre. 1985. *A Música Hoje 2.* São Paulo. Editora Perspectiva.

[41] Pinto, Nuno. *Portuguese music for clarinet and electronics: interactive processes in creation, interpretation and performance*. PhD diss., Catholic University of Porto, 2014.

[42] Pinto, Nuno. *Portuguese music for clarinet and electronics: interactive processes in creation, interpretation and performance*. PhD diss., Catholic University of Porto, 2014.



In these new relationships, both the composer and the performer have functions at every stage of the process. The composer, in addition to his previous role, is also a performer, influencing the audience's listening directly by controlling the electronics during the performance. The performer, on the other hand, no longer merely *deciphers the coded plot*, but has also an active involvement in the entire creative process, right from the beginning. This active role is due to the fact that the creative process is now conceived for the moment of the performance, which is a factor taken into account from the very start.

Knowing what is or isn't possible from a performative perspective is only possible when the performer is fully included since the beginning of the creative stage, making it a totally collaborative process[43].
The existence of the electroacoustic performer is born from this type of compositional thinking, representing a new creative paradigm built on collaboration and performance, being the one of most emblematic characteristics of mixed music.

Nevertheless, this new compositional paradigm can show some issues when the piece is performed without the original composer and performer, exposing its vulnerability in feasibility and revealing artistic contradictions.

Main issues

One of the main challenges is related to the accessibility/universality of a mixed music piece from a technical perspective. For instance, there is no standardization in programming language; each composer adopts their own interface, schemes, and models. Concerning programming in Max-MSP software, a vast number of patches were created without the concern of being understood by others. Understandably, creating an interface accessible to anyone is a laborious task that composers typically do not have the time for. However, this makes many patches completely inoperable by anyone other than the composer, immediately limiting performance possibilities for those not involved in the creation process.

Many composers, aware of this issue and concerned about the longevity of their work, have begun converting their programming into an accessible, user-friendly, and explanatory language (without compromising the sonic result). An example is Jean-Baptiste Barrière, the programmer for the electronics

[43]Pinto, Nuno. *Portuguese music for clarinet and electronics: interactive processes in creation, interpretation and performance*. PhD diss., Catholic University of Porto, 2014.

in Kaija Saariaho's pieces. Barrière's patches are highly educational[44], striving to encourage the practice and dissemination of Saariaho's works with live electronics. The patches even allow performers with only basic knowledge to independently control the entire electronic part, making the rehearsal and performance process significantly easier - enabling all this research work and my performances of the piece *Près* so far.

The discovery of these two contrasting approaches - an initially creative process closed in two agents followed by an attempt to adapt it and make it accessible to different performers- resulted in the identification of two main issues:

1. To what extent does making a work like *Près* accessible for performance (to the point where the instrumentalist has complete interpretative control over the electronic part) go against the nature of the piece itself, nullifying the principles of collaborative creation and performance on which it is based?

2. If, in the case of the piece *Près* being currently performed by an instrumentalist and an electroacoustic performer (neither of whom participated in the initial creative process), how should they act when the work was not originally conceived to be performed by agents external to the creative process?

Experiment 1: Rehearsing with an electroacoustic performer

To better comprehend the specifics of a mixed music performance involving an electroacoustic performer, I invited composer Eva Aguilar to join me in the performance of the piece *Près,* featured in one concert of the International Chamber Music Festival of Lisbon. As the performance was included in a festival, the rehearsal time in the concert hall was limited to two hours, too brief for a first experience of performing this piece as a duo. We decided to precede the rehearsal with an online meeting to set, at the very least, all technical details ("It is unwise to schedule the sound check directly before the performance, and it is crucial to reserve enough time to document the stage set-up so it can be accurately reproduced."[45]) – the equipment, technical planning, setup, and recording were our responsibilities, in addition to the musical interpretation.

On a technical level, we shared concerns. Besides adapting the available equipment[46] to the physical and acoustical characteristics of the venue, it was crucial for the electroacoustic performer to be positioned in a way that allowed adjusting the listening experience to the audience's perceptual standpoint while maintaining visual interaction with the on-stage performer.
We open up a corridor in the center of the room, between the audience. At one end, the cellist; at the other, elevated on a platform, the electroacoustic performer.

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[44] See Appendix 5 for the full transcript of *Près* patche's informative texts (*readme's.*)

[45] McNutt, Elizabeth. "Performing Electroacoustic Music: A Wider View of Interactivity." *Organised Sound* 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X

[46] **Note:** The hall only had two loudspeakers available, limiting the electronic part to be performed in stereo. Therefore, the relationship with space was not addressed here; this topic will be developed in the second part of this cycle.

Another shared concern was the need to decentralize the technological apparatus from the spotlight on the stage. Not only is it aesthetically unpleasing and a source of distraction for the audience, but it also represents one of the stereotypes of mixed music: that the fascination with the latest technological advancements is more important than the quality of the musical and artistic interpretation. To address this, we aimed to minimize the number of cables used, ensuring they didn't cross the front of the stage whenever possible. The speakers were positioned so as not to disturb the audience visually or acoustically throughout the rest of the concert. The audio interface and the computer were placed on a table near the stage. This proximity served two purposes: First, because if it were not so, the risk of the Bluetooth pedal (which I use to trigger electronic events) disconnecting would be very high. The second reason is that having the computer nearby also allows me to monitor which electronic event has been triggered in case of any doubts or accidental jumps.

In order for Eva to have a way of controlling the parameters of the electronics in distance, we decided to use the *MIRA interface* included in the Max-patch, enabling her to use an iPad as a MIDI interface via Wi-Fi. The iPad would mirror the *Mixer Window*[47] of the patch on the computer, making it possible to accurately control the electronic part.

On the day of the rehearsal in the concert hall, Eva focused on finely tuning the balance between performer, amplification, and various effects in relation to the acoustics of the venue. According to the composer, many indications of the electronic part were not very perceptible in reality, such as certain crescendos, diminuendos, and attacks—details I hadn't noticed with this precision before. Thus, we rehearsed the piece considering Eva's need to anticipate the dynamics of each event triggered by me (via the Bluetooth pedal). Eva also suggested various interpretative possibilities, like waiting longer in certain pauses "because the electronics asked for it" or emphasizing certain dynamic progressions "to make them more noticeable in this space".

In summary, the rehearsal was extremely enriching from a musical perspective, adjusting my interpretation not only to the venue's needs highlighted by Eva but also fine-tuning certain moments to her vision and opinion of specific passages. As a cellist, in addition to enhancing an intuitive musical reaction to the dynamics induced by Eva, the most noticeable changes were in the last section of the movement, from bar 119 onwards. All of the "wave" motifs (bars 130-135; 136-142; etc.) were expanded, as well as the pauses between them. Although not written down, this interpretative choice allowed the sounds of the electronics to expand and disseminate, enhancing the atmosphere that the composer had in mind.

[47] See Appendix 5 for the full analysis of the Max-patch of the piece *Près* by Saariaho.

3.2.4.2 Spatialization in Mixed Music

Contextualization

After searching and consulting various composers, there is, surprisingly, no relevant literature (or experience) about the use of spatialized electronics in mixed music. Only a few articles on real-time electronic spatialization are available- which is in part related to this topic since *Près* uses live electronics.

It was through conversations with composers and musicians experienced in interpreting this music that I gained insights into its main characteristics, both technically and artistically. The most crucial aspect revolves around the positioning of speakers, which, in the case of spatialized mixed music, are traditionally placed around the audience[48] (while the performer remains on stage), delivering a fully immersive experience for the listener. However, the performer has no possible awareness of the spatialization effects while playing, as they are not within the range of the speakers. It is, therefore, a phenomenon only reserved for the listener.

To discern the differences between the use and non-use of spatialization in the first movement of Kaija Saariaho's piece *Près*, I decided to conduct a live performative experiment comparing both possibilities. Several people listened to my performance of two excerpts of *Près*, and then provided their opinions on the perceived differences. The details of the experiment will be presented in the next section.

Experiment 2: Stereo Vs. Quadraphonic

Until this experiment, I have only played with stereo electronics when performing the piece. Having, for the first time, the opportunity to use the minimum requirements for spatialization (four loudspeakers), I decided to document the process in all phases, from defining the technical setup to the musical feedback received. The active participation of cellist Diogo Lopes was essential in phases three and five of this experiment.

1. **Technical Setup:**
   The experiment took place in room 6.35 of Codarts Kruisplein building. Based on the literature reviewed and with the help of the AV Team technicians, it was decided to position the speakers in a way that would create an equidistant perimeter, with the audience seated in the center. The cello would be outside this perimeter, facing the audience, following the format commonly used in various concert halls where solo mixed music pieces with quadraphonic electronics are performed.[49] Here is the illustrative example:

[48] Giomi, Francesco, Damiano Meacci, and Kilian Schwoon. “Live Electronics in Luciano Berio’s Music.” *Computer Music Journal* 27, no. 2 (2003): 30–46. http://www.jstor.org/stable/3681608.

[49] Such as *O’culto da Ajuda* and *Lisboa Incomum*, both venues located in Lisbon, Portugal.

2. **Selecting the excerpts of *Près:***
   In order to obtain complete feedback, I chose to play two contrasting excerpts from Saariaho's composition, both from the cello part and the electronic part perspective. Excerpt 1 is the beginning of the piece, where the electronic elements are a supportive texture, with their various layers blending with the instrument's natural reverberation[50]. In the Excerpt 2, however, the electronic component assumes a more pronounced role, allowing the identification of its layers: Sound events, spatialized reverb, and harmonizer. It is important to mention that the composer specified that the harmonizer should only be present in the back speakers, which has an influential impact on the electronic perception. The harmonizer is an effect that exists only in this excerpt of the piece.

3. **Achieving the right relation between cello and spatial electronics:**
   After making connectivity tests among the technical equipment (computer, audio interface, microphone, and four speakers), it was necessary to balance the relationship between the electronics and the cello. This is the most crucial phase of this type of work, which, after all this investigation, I can say is not a technical procedure but rather a musical one.
   I asked my fellow cellist, Diogo Lopes, to play in different registers and dynamics of the cello so that I could make precise adjustments (seated in the audience) in the relationship between the

[50] See the full analysis of the first movement of *Près* on Appendix 5.

natural sound of the instrument and the amplification, volume of audio files, spatialized reverb, and harmonizer.
Having done this work several times during my performances of the piece in a stereo system, I noticed that using more speakers tended to overshadow the cello sound. The increased number of sound sources required extra sensitivity in the search for the right fusion between the different elements.

4. **Performance- Stereo Vs. Quadraphonic:**
   As expected, the perceptible difference between stereo and quadraphonic electronics is not reliable at all from the cellist's perspective. When playing both variants immediately one after the other, the only noticeable difference lies in the size of the sound mass. When using quadraphonic sound, there is noticeably much more sound, allowing one to hear each effect in more detail. However, it becomes impossible to discern the sound in space, as it practically seems unidirectional for the performer.

5. **The perspective of the listener:**
   I asked my colleague Diogo Lopes and my main subject teacher, Jeroen den Herder, to provide feedback and compare their perception of the excerpts in the stereo and quadraphonic versions. For the first excerpt, Diogo Lopes mentioned that when using stereo the focus on the cello is bigger, and the general sound is more direct. He said that with four speakers the electronics sound better, allowing for a clear understanding of all their parameters and aspects, but having less focus on the performer. Regarding the second excerpt, Diogo stated that the difference was significant. In stereo, the natural sound of the cello was noticeable, but the electronics were not so distinct. With spatialized electronics, the sound coming from behind provided "a more complete experience and a fuller sound," even more noticeable than in the first excerpt. Diogo concluded, "For an optimized result, you should definitely use four speakers."[51]
   According to Jeroen den Herder, the sound is fuller when using four speakers, with more presence of electronics, causing the cello to move more into the background. The professor described this as primarily a "matter of taste" that "depends on the musical moment." In general, the sound from the four speakers shifts the listener's focus from the cello to being "centered on the whole space." He concluded that using four speakers and all the differences in perception "is just a different concept."

6. **Conclusions:**
   After analyzing the course of the experience and all the feedback received, I have concluded that the use of quadriphonic electronics significantly changes the perception of the listener. Taking this into account, it is essential that when this type of work is performed with spatialization, there is time to adjust very precisely the positioning of the speakers in relation to the audience, as well as the balance between the parameters of electronics and the instrument. This procedure should be made with someone with musical knowledge. It is also necessary to consider that we are entering a different listening paradigm[52], changing the listener's focal points and subsequently their sensations.
   In summary, the use of spatialization allows the composer's musical use of the surrounding space to be carried further, allowing the aim for an immersive sound experience in an optimized manner.

[51] See Appendix 5 for the full feedback of this experiment.
[52] Trochimczyk, Maja. 1994. "*Space and spatialization in contemporary music : history and analysis, ideas and implementations.*" Thesis, Schulich School of Music. McGill University.

As a performer, this experience proved to be particularly valuable in understanding that, even though spatialization in this setting is a parameter I cannot control or directly experience, its impact on the overall perception of the piece is significant. It is crucial for the interpreter to take this into consideration, as in the case of a malfunction in spatialization (which could be as simple as an unbalanced electronic part), all their musical interpretation could be affected, since in the end everything goes through the speakers.

Experiment 3: Spatialization in the Studio

After conducting the last experiment on the perceptual differences between stereo and quadraphonic sound, I asked for the opinion of René Uijlenhoet on the received data and the conclusions drawn. According to the teacher, some perceptual clash for the listener when using spatialization is normal, given that the audience is not used to having sound come from multiple directions, especially from behind. This can cause some discomfort because what the audience hears does not correspond to the visual perception of the sound source (the cello), which is in the front.
To better understand the perceptual differences as a listener, I decided to experiment with the Max-patch of the electronic part together with René, experimenting with different types of spatialization (quadraphonic, hexaphonic and octophonic). During this process, several tips and explanations of specific procedures on how to handle/test the entire technical setup emerged.

- **Technical Procedures:**
  The experience took place in Studio 4.14 at Codarts. The studio is equipped with an eight-speaker system and an analog mixer that allows for various spatialization combinations, from stereo to octophony. On a technical level, the initial challenge of the experience was related to compatibility. For unknown reasons, my computer did not recognize several interfaces available in the studio, and the only one that was compatible did not recognize all the necessary outputs from my Max-MSP. I ended up having to use René's computer to open the patch for the piece "Près."
  René advised me to always have a separate Max patch that individually tests the sound of each speaker, where each note of a chord is mapped to a different speaker. This way, it is possible to quickly verify if all the physical routing is functioning without having to use the sounds of the piece itself.

- **Musical Experiments:**
  Firstly, we experimented with the electronic part in a quadraphonic system, adjusting the levels of all parameters (events, reverb, and harmonizer) to the acoustic specifics of the studio. Having done this balance procedure times before, this phase of the process was quite swift. The studio setup sounded much clearer than in room 6.35. This noticeable difference is a normal phenomenon.[53]
  Next, we tested the patch in an octophonic version, using eight speakers instead of four. To my surprise, during the routing, René pointed out something I hadn't realized: "The patch is designed for four outputs. Even with spatialized sound, there are only four sound sources for each effect. If they are placed all around the audience (as indicated by the composer), the sound signals will be

[53] McNutt, Elizabeth. “Performing Electroacoustic Music: A Wider View of Interactivity.” Organised Sound 8, no. 3 (December 2003): 297-304. doi:10.1017/S135577180300027X

duplicated." In fact, when we played the electronic part, the sonic difference was not relevant. Just more volume, which is not even desirable.

- **Conclusions:**
  This experience led to the conclusion that using a spatialization with more than four channels (quadraphonic) doesn't make sense on a technical level. Therefore, from a musical perspective, it doesn't make any sense to adopt any other immersive environment beyond quadraphonic.

3.2.5 Interventions / practical application

3.2.5.1 The performance with an electroacoustic player

The decision to perform *Près* with another musician operating the electronics (composer Eva Aguilar) marked a significant shift in my interpretative approach. For the first time, I was able to treat the electronic layer not as a tool I was managing, but as a musical partner — an active voice in real-time dialogue.

Several interpretative choices in this performance emerged directly from our rehearsal process:

- **Timing and gesture**: Eva's dynamic control[54] over the electronics allowed me to shape certain gestures more organically — especially in transitions where I would typically be constrained by pedal timing.

- **Extended pauses** and **wave-like articulations** in the final section were intentionally expanded to allow the electronic reverb and transformation effects to resonate fully in the space — a decision that emerged collaboratively in rehearsal.

- **Technical clarity through MIRA**: Eva used the Max-MSP MIRA interface on an iPad to monitor and balance electronic parameters remotely[55]. This allowed for greater precision in dynamic balance and freed me from needing to check the laptop visually during performance, enhancing my own concentration and musical responsiveness.

Performing *Près* in this collaborative format introduced a different kind of attentiveness — one closer to chamber music. The electronics, shaped live by another musician, became a responsive presence, opening interpretative space for nuance and spontaneity. This experience reinforced that the role of the performer in mixed music is not fixed: it can expand or contract depending on the distribution of responsibility, trust, and listening.

Intervention Recording 01

- **Kaija Saariaho: *Près*, for cello and live electronics (1992)- 1st movement**

- **Recorded in the Portuguese Chamber Orchestra's headquarters *(Sede OCP)*; 06-09-2023; Cello: Pedro do Carmo; Electronics: Eva Aguilar; duration: 7'16''**

[54] The performance draft for the electronic part is available *here* (and on appendix 5).
[55] See image 1.

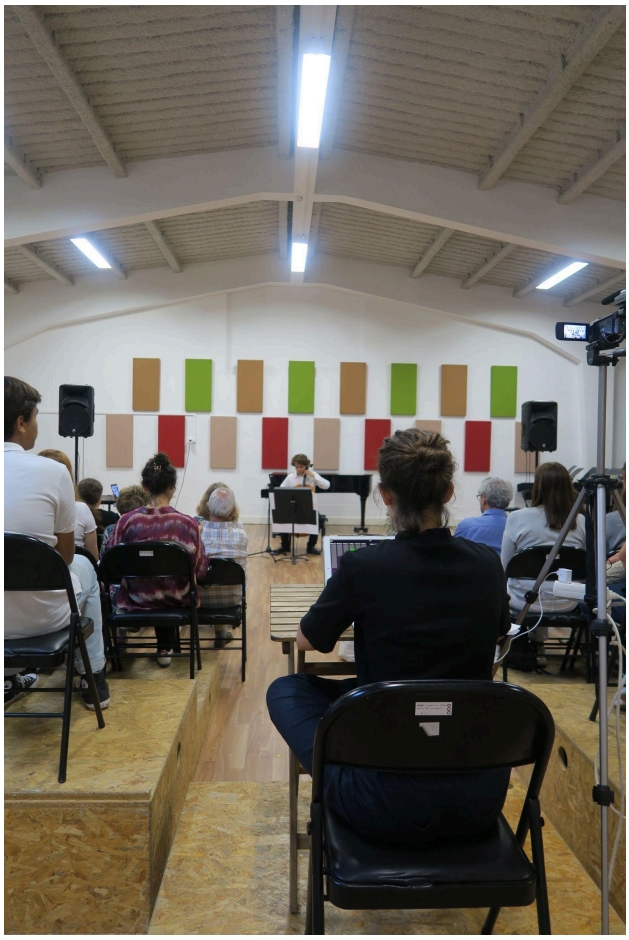

Image 1 — Performance of *Près,* by Pedro do Carmo and Eva Aguilar

3.2.5.2 Interventions from the studio

This intervention aimed to apply the insights from earlier spatialisation experiments to my solo performance practice of *Près*. Based on comparative listening sessions and technical rehearsals, I opted for a quadraphonic setup using four speakers — two in front and two behind the audience — as specified in the composer's documentation. This setup was tested and documented in Studio 6.35 at Codarts.

To illustrate the implications of spatialisation for performance and electronics balance, I recorded two contrasting excerpts of the piece:

- **Excerpt 1**: Opening (until bar 36)
- **Excerpt 2**: Closing section (from bar 136 to end)

The choice of these passages allowed me to explore and document the impact of spatial projection on different types of electronic material: background textures and prominent effects such as harmoniser and spatial reverb.

In the studio, I applied earlier findings related to gain structure and spatial balance. The configuration was carefully adjusted to preserve the articulation and clarity of the cello part, while also ensuring that the electronic layer could be perceived in its full dynamic and spatial range.

Although the immersive differences are not fully captured in stereo, these excerpts document how my cello interpretation was shaped by spatial considerations:

Intervention Recording 02

- **Kaija Saariaho: *Près*, for cello and live electronics (1992)- Excerpts**

- **Recorded in Codarts 6.35 ; 17-11-2023; Cello & Electronics: Pedro do Carmo; duration: 3'38"**

3.2.6 Outcomes

During this second research cycle, the topics of the inclusion of an electroacoustic performer and the relationship with the space were simultaneously developed.
To better understand and analyze the findings of this phase of research, the final outcome is a comparison of two excerpts from *Près* (selected for experiment 2 of data collection) between the reference recording and the interventions recording.

Outcome Recording 01
(comparison between Reference Recording and Intervention Recording 01)

Outcome Recording 02
(comparison between Reference Recording and Intervention Recording 02)

3.2.7 Feedback, reflection and conclusion

This research cycle provided valuable insights into two essential dimensions for the performance of *Près*: the role of the electroacoustic performer and the use of spatialisation as a compositional and interpretative element. These insights emerged directly from the comparative analysis between the reference and intervention recordings, as well as from the structured experiments and rehearsals documented throughout the cycle.

1) **Presence of the Electroacoustic Performer:**
   Although *Près* allows for the electronics to be operated solely by the cellist, this cycle demonstrated clear musical benefits in having a second performer actively controlling the electronic part. The collaborative rehearsal and performance with composer Eva Aguilar introduced a noticeable increase in musical sensitivity—particularly evident from bar 134 onwards, where dynamic transitions and phrase endings benefitted from mutual responsiveness and anticipation. Reflecting on this experience, Aguilar summarised clearly:

   > "If the instrumentalist finds it stimulating to operate the electronics on stage, this is entirely possible, provided they possess the necessary musical and technological fluency. Nevertheless, a collaborative performance brings significant artistic benefits—particularly regarding textures, timing, and responsiveness, all of which require quality rehearsal time between both performers."[56]

   In essence, the presence of an electroacoustic performer, while not strictly necessary, enhances interpretative responsiveness and adds a chamber-like dimension to the musical result.

2) **Use of Spatialization in the performance of *Près*:**
   After all the experiences and interventions, it can be concluded that the use of quadraphonic spatialization is crucial to achieving the desired final result by the composer, bringing greater timbral richness and a more comprehensive interpretation. Comparing the reference recording (recorded in stereo) with the intervention recording using spatialization, there is a noticeable improvement in the overall sound
   quality, including that of the cello itself - as it is being amplified, passing through the patch and speakers. This is because when more loudspeakers are used, the sound is divided between them, with less sound per speaker. The less variety of sound a speaker produces, the greater its ability to keep it more faithful.[57]

[56] See the full questionnaire from Eva Aguilar on Appendix 5.

[57] Normandeau, Robert. “Timbre Spatialisation: The Medium Is the Space.” *Organised Sound* 14, no 3 (2009), 277–85. doi:10.1017/S1355771809990094.

3.2.7.1 Conclusions

This cycle demonstrates that interpretative depth in mixed music performance extends beyond technical mastery and score interpretation. It requires thoughtful engagement with collaborative and spatial elements—factors often treated as secondary or external. The rehearsal process, experimentation, and comparative analysis carried out here highlighted the artistic value inherent in spatialized sound and shared interpretative control.

Thus, the findings suggest that an optimised performance of *Près* would benefit significantly from including an electroacoustic performer in rehearsal and performance, as well as adopting a quadraphonic spatialisation setup, carefully adjusted to the acoustics of each specific venue.

Together, these dimensions support a more integrated and dynamic musical performance—one in which cello and electronics interact responsively, becoming parts of a unified musical experience. These insights open new artistic possibilities and lay important groundwork for the collaborative and spatial questions to be explored further in the next research cycle.

3.3 Third research cycle

This final research cycle centres on the practical application of key findings developed in the earlier stages of the project, through the creation of a new work for Baroque cello and real-time electronics. Beyond consolidating previously explored concepts, this phase aimed to address two key challenges identified earlier: the performer's limited perception of spatialisation, and the dependence on external mediation (electroacoustic performer) to operate the electronic component. The resulting work proposes concrete artistic and technical responses to these issues by developing an alternative model of interaction and control.

The decision to collaborate with composer Marta Domingues stemmed from a shared aesthetic and methodological sensibility — particularly a common interest in open, collaborative processes where sound, gesture, and space evolve through continuous dialogue with performance practice. The new piece builds directly upon the collaborative creation model proposed by Nuno Pinto[58], in contrast with Pierre Boulez's conception of composer, performer, and performance as separate and unidirectional entities. Instead, it suggests a co-constructive framework in which these roles are continually redefined through interaction. This position resonates with Franziska Schroeder's observation of "the blurring of definitions" [59] in technologically mediated performance — not only between composer and performer, but also between gesture and system, human and machine. Both Pinto's model and Schroeder's perspective inform the conceptual basis for the model of performance proposed in the new piece. Their implications will be developed progressively through the present research cycle, as the work's technical structure and gestural language are shaped around the notion of embodied autonomy.

This cycle is presented across three creative residencies, tracing the process from early conceptualisation to the final configuration of the performance setup. It concludes with a reflection on the accessibility and dissemination of the electronic system, supported by expert feedback to ensure its long-term artistic viability and performative autonomy.

[58] Pinto, Nuno. *Portuguese music for clarinet and electronics: interactive processes in creation, interpretation and performance*. PhD diss., Catholic University of Porto, 2014.
[59] Schroeder, Franziska. "Editorial: Bodily Instruments and Instrumental Bodies." *Contemporary Music Review* 31, no. 1 (2012): 1–6.

3.3.1 Residency 1: Primordial Conceptualisation; Cello Timbre Exploration; From Gesture to Notation: A Collaborative Mapping

3.3.1.1 Primordial Conceptualisation

The first meeting with the composer Marta Domingues (held on 27 and 28 December 2023 at Cigarra – Associação Cultural[60]) began with a creative brainstorming session, during which we shared and developed the various ideas each of us brought into the process. This initial dialogue was grounded in several focal points of this ongoing research, particularly the exploration of timbral metamorphosis in the first movement of Saariaho's *Près*, where sonic transformation is achieved through nuanced use of bow contact points[61].

This variety of contact points — which Marta described as a "nuanced expressive resource"[62] — requires the performer to develop a fine sensitivity to the instrument's response across different strings and positions. As professor Jeroen den Herder puts it, such knowledge represents "an enormous capacity to receive information from what the instrument demands"[63], to which the performer responds physically and musically.

This shared understanding became the conceptual entry point for the piece. We chose to centre the performer's role on their dimension as a "receiver/reactor", prioritising their physical sensitivity and capacity to absorb information. The central aim of this approach was to expand the expressive potential of the piece by giving the performer space to shape their playing in response to real-time stimuli emerging through the following relationships:

- with physical gesture as a primary expressive force;
- with the physical mechanisms involved in sound production;
- with the instrument and its material behaviour;
- with the surrounding acoustic space *(to be explored further in Residencies 2 and 3);*
- with real-time electronics *(to be developed in Residencies 2 and 3).*

These conceptual coordinates gave shape to our starting point. Based on them, we began outlining our aesthetic and creative possibilities, focusing first on the timbral and expressive potential of the cello. This exploration was conducted in a fully collaborative manner (later developed), always grounded in the core principles defined above.

[60] See more here: "Cigarra-Associação Cultural".
[61] See: Research Cycle 1 - Dominating Extended bow techniques: Overpressure and Contact Points.
[62] See: Appendix 4- Third research cycle- Questionnaire 2: Marta Domingues (composer)
[63] See interview with Jeroen den Herder.

3.3.1.2 Cello Timbrical Exploration

In order to practically define the best conditions for exploring the performer's role as "receiver/reactor," we decided to continue developing certain findings that had emerged in earlier phases of this research. Drawing, as previously mentioned, from Saariaho's expressive use of bow contact points, we chose to creatively extend one of the experiments proposed by Jeroen den Herder, who recommended the use of gut strings to more clearly emphasise the expressive value of bow pressure in *Près*:

> This type of music has some common aspects with baroque playing, regarding bow use and practice. Modern strings don't require the same care and consciousness for contact points that the gut strings need, although this music is based on that type of attention.[64]

We therefore experimented with a series of slow gestures on the Baroque cello — in practice, short improvisations based on ideas suggested in the moment by the composer. The distinctive sound quality of gut strings, which the composer described as "expressive and intimate, with a soft timbre", immediately drew our attention.

What struck me most at first was the physical demand required to adapt to the instrument in order to let each gesture speak clearly[65]. The sensitivity (or even fragility) of the gut string required constant micro-adjustment, far more than what is needed to play the same gesture on a modern cello. Given these sonic characteristics, and their natural alignment with the conceptual concerns previously outlined — particularly those related to the body's role in sound production and the performer's physical relationship with the instrument — we began shaping the piece specifically for Baroque cello and live electronics. Our timbral research became focused on gestures that further intensified this embodied relationship, including the use of scordatura in the lower registers. The reduced string tension in this configuration lowers responsiveness, demanding even greater attentiveness from the performer.

A final and central aspect of this timbral work was the introduction of preparation in the cello — Using simple materials and tools to modify the instrument[66]. This allowed us to expand its timbral palette while preserving its performative identity. After testing several options — such as bow preparations, bow hairs tied around the strings, or cassette tape — we selected a round-shaped wolf-tone eliminator[67] clipped onto the A string. According to the composer[68], this preparation created a sonic contrast to the Baroque cello's intimate tone, introducing it a more abrasive, almost screaming character, neither resembling the modern cello (see Excerpt 3 below). Beyond its expressive impact, the eliminator is easy to install and visually discreet, not interfering with the performer's engagement or altering the instrument's overall appearance.

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[64] Feedback from Jeroen den Herder about past research- see research cycle 1- Quasi-Experiment 3:Overpressures in gut strings.
[65] From self-critical feedback of Cycle 3.

[66] "install the various items on the cello with the purpose to have more tonal options". From "Essay Example: Musical Instrumental Preparation" SpeedyPaper, Jul 16, 2019. Accessed on April 06, 2025.
[67] A wolf-tone eliminator is a small device used to suppress the unstable resonance (*wolf tone*) caused by interference between a played note and the natural resonances of the instrument's body — less a correction than a micro-intervention in the instrument's acoustic identity. From: "Wolf tone". Encyclopaedia Britannica. Accessed April 06, 2025.
[68] See: Appendix 4- Third research cycle- Questionnaire 2: Marta Domingues (composer).

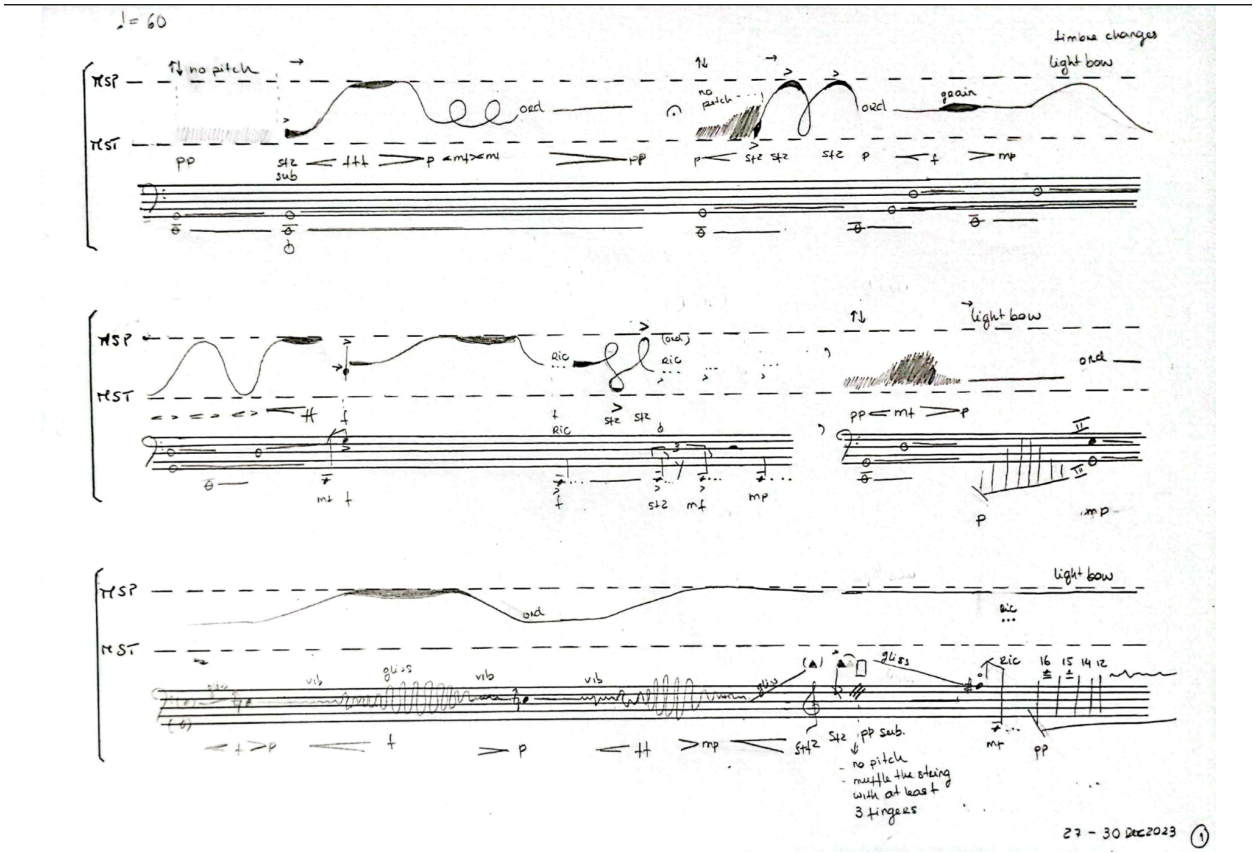
The following excerpts document the materials developed during this timbral phase, which later became the foundation for the compositional gestures in the cello part of the piece:

- Excerpt 1 – Long notes
- Excerpt 2 – Bow contact points explorations
- Excerpt 3 – Wolf-tone eliminator: isolated possibilities
- Excerpt 4 – Improvisation using the wolf-tone eliminator

3.3.1.3 From Gesture to Notation: A Collaborative Mapping

The topic of gesture notation is one of considerable descriptive complexity and remains far from consensual in academic discourse. It could easily become the subject of an independent research project. For that reason, this section does not aim to provide a comprehensive analysis of the adopted system, nor was it ever a priority to develop a notational method for the cello part. Rather, I will focus briefly on why this specific notation was chosen and what expressive advantages it brings to the piece as a whole.

Following the timbral exploration phase described earlier, the composer proposed an initial draft of the first two musical phrases of the piece, based on the gestures and improvisations we had developed collaboratively. After a period of collaborative refinement, we arrived at the following version:



These three systems represent the first two phrases of the piece (the second phrase begins after the breath-like comma in the second system). The notation refers only to the cello part and is organised across two lines: the top line relates to bowing gesture, indicating the trajectory across contact points, the pressure applied, and the specific technique (e.g. ricochet, muted strings, pizzicato). The lower line, in traditional staff notation, references pitch range, using the four open strings of the standard cello tuning as guides. It also suggests the duration of each gesture and includes light rhythmic cues.

The influence of my earlier research into *Près* is clearly present: the centrality of contact points as an expressive source for gesture, and the organic notation of overpressure — visible in the thickened bow trajectory — draw directly from Saariaho's approach (see previous overpressure experiments).

The collaborative process was also central at this stage, particularly in refining the composer's proposal. It was my suggestion to introduce a reading line specifically dedicated to bow contact points, allowing the gesture's development to unfold from this material focus. The use of open string references to indicate pitch space also arose from my input.

The notational language adopted here reflects the fundamental concepts explored throughout the practice: the idiomatic core of the piece lies in the transformation of gesture, where the performer is invited to *draw* the expressive line of the gesture with the bow. This line must take into account the responsiveness of the gut strings, allowing the performer the necessary time to develop each transformation in full. This is the rationale behind the absence of barlines or imposed metre: rhythmic flow and gestural direction emerge naturally when the performer responds to the instrument in real time.

This openness of notation was also conceived in light of the future integration of real-time electronics (to be developed in Residencies 2 and 3), where flexibility in timing and gesture will allow for greater sensitivity and responsiveness to the electronic layer.

The following video documents the first reading of the excerpt above[69], recorded on December 28th, 2023:

First Reading of the score- excerpt (Intervention Recording 03): *LINK*

[69] Also available for download in AR Media: *link*

3.3.2 Residency 2: Preliminary Experiments with Electronics; Critical Reflection on Spatialization and the Presence of the Electroacoustic Performer; Solutions to the Identified Issues

3.3.2.1 Preliminary Experiments with Electronics

After the musical material for the cello part had been outlined during the first residency, the second meeting between the composer and me began with an open-ended experimentation session exploring possibilities for the electronic component, grounded in the conceptual approach and musical ideas previously defined. We began by applying the conceptual thinking developed earlier to a guiding question: *What kind of electronic material could best support the idea of the performer as a "receiver/reactor", and induce a temporally flexible, embodied interaction between performer and electronics?*

In addressing this question, we revisited *Près* by Kaija Saariaho, focusing on her own description of electronics as a medium that "continue[s] and expand[s] the musical gesture of the solo instrument in many different directions"[70]. This notion of electronics as an expressive extension of the cello guided our session. The plan was to record short samples drawn from the improvisations developed in the first residency, as well as from the two musical phrases already composed. These samples were then processed through a range of electronic processes — such as ring modulation, frequency modulation or timbral alteration through various filters (low-pass, bypass, high-pass)[71] — to examine their sonic characteristics and assess whether they aligned with our conceptual direction.

This session was not intended to result in final choices regarding which effects to use. Instead, it served to open up a wide field of expressive possibilities, functioning as a study environment for the composer to determine, before the next residency, which processes best support the expressive expansion of the cello, and how they could be implemented technically using Max-MSP.

Several relevant questions emerged from this session — particularly how to achieve, both musically and technically, the conditions for a fluid, real-time interaction between the cellist and the electronics. These questions would later become central to the next phases of the process.

3.3.2.2 Critical Reflection on the Use of Real-Time Spatialization

During initial experiments with electronics, it became evident that real-time spatialization holds significant potential as an active compositional element. The possibility of expanding and transforming the cello's sound across different points in space not only reinforces its sonic presence but also introduces new layers of relationship between the performer, musical gesture, and surrounding environment. This approach aligns closely with the central idea of this piece: the cellist as a sensitive receptor and reactor who physically integrates the sound transformations.

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[70] From *Près'* notes in Saariaho's website:"*Près*." Accessed on April 6, 2025.
[71] See: Appendix 4- Third research cycle- Questionnaire 2: Marta Domingues (composer)- question 6.

We drew inspiration from Kaija Saariaho's piece *Près*, where electronics not only prolong the sound of the instrument but also project it spatially through a quadraphonic system, creating a sonic environment extending beyond the performer's body. This spatial conception serves as both a model and a point of critical reflection. In *Près*, the cellist remains outside the spatialization field—positioned on stage, detached from the audience's auditory experience. This separation raises a critical question: how can the performer react expressively to space if they do not experience it in the same way?

During past experiences of this research, this limitation became clear. By placing the cellist outside the spatialization field, their gesture could not fully interact with the spatial transformations, resulting in only partially informed reactions. This contradicts the piece's conceptual principles, which seek to merge sound, gesture, and space into a unified performative body — one in which the performer acts not merely as a sound source, but as a "receiver/reactor", whose musical decisions emerge through embodied responsiveness to his different surroundings.

Hence, the central question guiding the technical and performative development of our piece emerged: *how can we ensure the cellist has an integral perception of real-time spatialization to react expressively to its transformations?*

This question would go on to inform both the technical and performative solutions developed in the following stages of the project.

3.2.2.3 Critical Reflection on the Presence of the Electroacoustic Performer

From the outset, both the composer and I shared the goal of enabling the cellist to autonomously manage the full performance setup. This objective was motivated not only by practical concerns — such as facilitating the piece's dissemination and reducing dependence on external agents — but also by an artistic principle: the electronics in this piece should function as a direct and organic extension of the cellist's gesture.

This concept draws on, but also departs from, the model presented in Kaija Saariaho's *Près*. While the piece employs electronics as an expressive prolongation of the cello (especially through the use of the space), it relies in performance on a dedicated electroacoustic performer to operate and balance the electronics in real time. However, findings from Cycle 2 of this research demonstrated that this performer's presence, while musically enriching, is not strictly necessary. As highlighted by composer Eva Aguilar during collaborative sessions, the electronics can indeed be managed by the cellist, provided they possess sufficient technological fluency[72]. Nevertheless, she also noted that the collaborative format opens up new layers of musical interaction, particularly in the fusion of texture and timing.

The present piece takes this as a point of departure. We aim not to reject the collaborative potential of a second performer, but to explore whether - and how - these expressive interactions can be preserved or even reimagined within a model of full performer autonomy.

This leads us, again, to another question: *To whom should expressive control of the electronics belong — to the cellist who originates the gesture, or to an external figure who mediates and transforms it?*

[72] See the full questionnaire from Eva Aguilar on Appendix 5.

3.2.2.3 Solutions to the Identified Issues

The issues raised in the previous phases — the limitations of spatial perception and the need for mediation by an electroacoustic performer — converge on a common question:
How can we ensure that the cellist autonomously experiences and shapes the electronic extension of their gesture in real time?

This proposal responds to that question by adopting a performer-centred approach, rooted in both artistic coherence and performative viability. Drawing on Di Scipio's[73] perspective, we understand dedicated digital interfaces and real-time signal processing not as neutral technical tools, but as active components of the compositional and performative process. These systems engage in a dynamic feedback loop with the performer and the acoustic environment, contributing to the formation of timbre, space, and interaction. In this sense, the electronic system becomes part of, in what the author defines, an ecosystemic model of performance - where gesture, sound, space, and technology operate in continuous, reciprocal interaction.

1. Integrating the Cellist into the Spatial Field

Instead of the traditional model (as in *Près-* see Fig. 1), we propose placing the cellist directly within the quadraphonic field (see Fig. 2). This integration situates the performer within a complete ecosystemic system, allowing immediate reactions to spatial changes, organically incorporating them into the performative gesture. The performer's immersion in the same sonic environment as the audience enables a shared spatial experience, further reinforcing the aesthetic coherence between gesture, sound, and space. Crucially, this spatial repositioning also aligns the cellist's auditory perspective with that of the audience — creating a shared listening environment that dissolves the traditional distance between performer and listener. This choice is further reinforced by the use of a Baroque cello, whose intimate, nuanced timbral characteristics benefit greatly from proximity-based listening and immersive spatialization, reinforcing both the audience's perceptual engagement and the cellist's responsive expressivity.

[73] Di Scipio, Agostino. "'Sound Is the Interface': From Interactive to Ecosystemic Signal Processing." *Organised Sound* 8, no. 3 (December 2003): 269–277. https://doi.org/10.1017/S1355771803000244.

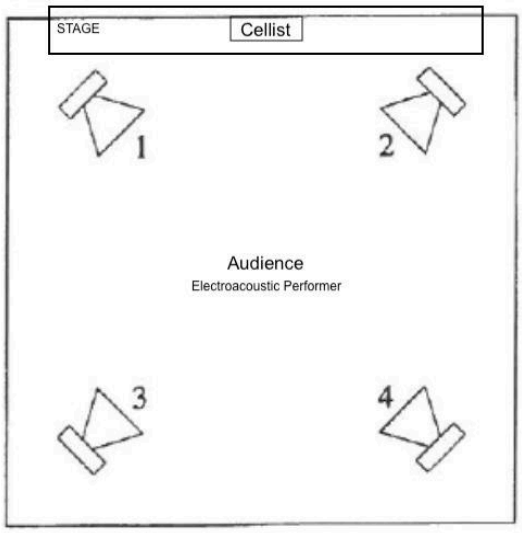

Fig. 1- Traditional Model

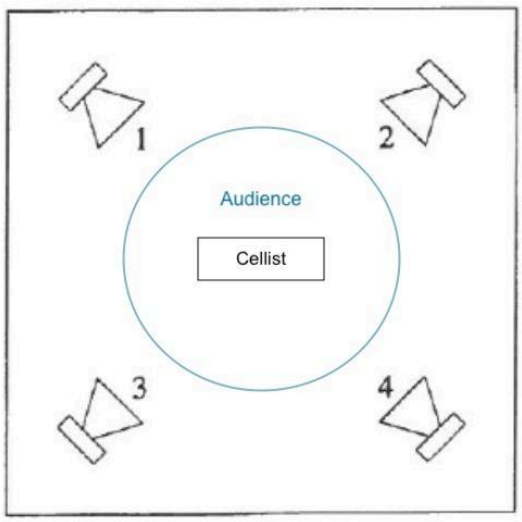

Fig. 2- Proposed Model

2. Dedicated Control Interfaces

The decision to forego an external electroacoustic performer — while acknowledging its artistic potential, as discussed in the previous cycle[74] — demands a control system that is both reliable and expressive. The solution involves the use of two dedicated, body-integrated interfaces[75]:

- **Bluetooth Footswitch**: Enables the triggering of pre-mapped electronic events linked to specific musical gestures. This interface was already employed in my interpretation of *Près* (and its adaptation here serves continuity, not innovation).

- **MIDI Expression Pedal**: Introduced as an additional layer, this pedal allows the performer to shape multiple parameters (such as amplification, velocity of spatial diffusion, reverb intensity) in real time. However, its integration is not without challenge: operating two interfaces simultaneously, particularly on a Baroque cello — which lacks an endpin and requires a more delicate balance — introduces new physical and gestural demands that must be acknowledged.

This dual solution — placing the performer within the spatial field and enabling control through dedicated interfaces — offers a coherent response to the artistic and technical challenges identified throughout this research cycle. It redefines the traditional roles of interpreter and technician, proposing instead a hybrid performer capable of embodying sound, space, and control within a single expressive framework. However, these strategies are not neutral. They shift complexity into the performer's body and demand a reconfiguration of gesture, attention, and time. Whether this model of technological autonomy proves

[74] See research Cycle 2: "3.2.4.1: The electroacoustic performer".
[75] These are the exact models used in this residency for the Bluetooth Footswitch (*link*) and MIDI Expression Pedal (*link*).

artistically sustainable and performatively fluid remains an open question — one that will be critically tested in the next residency through real-world experimentation.

3.3.3 Critical Reflection: Rethinking Technological Autonomy in Performance and Practice

As the setup evolved, we encountered a new layer of difficulty — managing a second control interface without compromising the natural continuity of the gesture. While the use of a Bluetooth footswitch had already been explored in *Près*, the introduction of a MIDI expression pedal presented new demands, particularly when integrated into the physicality of Baroque cello performance. The absence of an endpin in this instrument alters the performer's balance and naturally impacts his whole way of playing, requiring greater bodily attentiveness and sensitivity in postural stability — aspects that affect how control interfaces are integrated into the gesture.

Such a configuration introduces a complex multitasking environment, where instrumental execution, critical listening, and real-time control and reaction coexist in interdependence. This interplay between physical action and mental processing has been explored in various performance practices. One such example is a study by Çorlu et al. on opera singers[76], which showed that increased cognitive load — in this case induced by a simultaneous working with memory tasks — significantly impacted the temporal stability of performance[77]. Although this study focused on vocal music, the implications resonate with our experience: divided between the instrumental and technological domains, the performer's attention becomes particularly vulnerable to cognitive overload in complex technical settings. In the case of this piece, such overload may compromise not only the temporal continuity of the musical gesture but also the cellist's sensitive listening and reactive capacity in response to the nuances of the electronics. This stands in direct tension with the initial conception of the performer as a "receiver/reactor", whose expressivity depends precisely on attentive and responsive multi-layered listening.

The third residency will be dedicated to the development and testing of the electronic system in a quadraphonic environment, precisely with the aim of mitigating these risks. This phase will be essential for refining the articulation between gesture and technology and for evaluating, in a real performance context, the extent to which the system allows for the preservation of the performer's active listening and expressive autonomy.

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[76] Çorlu, Muzaffer, Pieter-Jan Maes, Chris Muller, Katty Kochman, and Marc Leman. "The Impact of Cognitive Load on Operatic Singers' Timing Performance." *Frontiers in Psychology* 6 (2015): 429. https://doi.org/10.3389/fpsyg.2015.00429 Accessed on April 05, 2025.

[77] Çorlu, Muzaffer, Pieter-Jan Maes, Chris Muller, Katty Kochman, and Marc Leman. "The Impact of Cognitive Load on Operatic Singers' Timing Performance.

3.3.4 Residency 3: Selection of Electronic Effects; Collaborative Composition of the Electronic Part; Quasi Experiment: Cellist Positioning – *Inside vs. Outside the Spatial Field*

3.3.4.1 Selection of Electronic Effects

The third residency, held from 14 to 16 March 2024 at Codarts (KP 6.41), marked the beginning of the practical construction of the electronic part of the piece. The work carried out during this phase followed previously defined conceptual directions, particularly the idea of the performer as a “receptor/reactor” and their integration within the listening space.

For this session, the composer brought a new version of the Baroque cello part[78], already close to its final form. The musical gestures included in this version reflected the findings from earlier stages and were conceived with the performer’s new position — within the audience space — in mind. This awareness was particularly evident in the choice of gestures with reduced volume but high timbral richness, where expression arises through fragility and nuance. When projected from within the audience space, these gestures become more clearly perceivable and impactful, something that would be lost in a traditional stage setup.

Alongside the cello part, the composer introduced an initial version of the Max patch. This patch did not yet offer the technical autonomy previously envisioned for the performer, but it already contained the core effects to be tested. For the purpose of this residency, the patch was operated by the composer during the session, allowing for real-time experimentation and joint evaluation of the gesture-effect relationships.

The effects implemented in this first version included:

- Amplification;
- Reverb;
- Spatialised delay;
- Spatialised pitch shift.

We began by applying each of these effects to simple gestures from the cello part, in order to observe their sonic and spatial behaviour in a performative context. In many cases, the gesture was adjusted in response to the effect, rather than the other way around. Our aim was to understand when the relationship between gesture and electronics became expressive, coherent, or problematic. To simulate performer control, some parameters were assigned to the MIDI expression pedal, and we tested different control ranges and response types.

Throughout the session, it became clear that the relationship between gesture and electronics does not always operate under a logic of control. In several instances, the system’s response was unexpected or resistant, prompting changes to the gesture itself. This mode of interaction suggests a shift in the performer's role — from controller to collaborator — in a dialogue with the technology. Rather than

[78]Available for download in AR Media: *link*.

functioning as a passive tool, the Max patch began to behave as a responsive element within the performance, shaping the expressive outcome as much as the performer's intention.

This collaborative interplay between body, system, and space informed various artistic decisions (better explained in the next section), including the exclusion of certain effects and the refinement of others.

3.3.4.2 Collaborative Composition of the Electronic Part

After the initial tests with the Baroque cello and real-time electronics inside the quadraphonic system, we decided to compose the electronic part collaboratively. The sequence of effects was developed gesture by gesture, through a process of mutual listening and adaptation between the composer and myself. Each gesture was tested and refined with particular attention to its articulation through the control interfaces — integrating the technological interaction into parts of the gesture that do not compromise its natural flow and, in fact, are organically suited to it, whether in upbeats, bow prolongations, or sustained notes. The aim was to incorporate electronics as a natural extension of the instrumental gesture:

Illustrative Video Example: Intervention Recording 04

Although this thesis does not focus on collaborative composition methodologies per se, this process was crucial for preserving the conceptual integrity of the piece, particularly the notion of the performer as "receiver/reactor". Rather than applying effects in an abstract or externally imposed manner, the electronics were shaped in direct response to the expressive quality of each gesture — reinforcing a model where control emerges through listening (to the instrument, the musical gesture, and the electronics within the quadraphonic space), rather than through premeditated calculation.

In this sense, the process was not only creative but also performative in nature: it served as a test of whether the principle of reactive embodiment could be sustained within a complex technical framework. Notably, no significant cognitive overload was experienced. On the contrary, by anchoring each electronic transformation in a temporally fluid, embodied gesture, the interaction remained intuitive and expressive. This outcome reinforces the idea that maintaining the performer's embodied listening capacity is key to preserving fluency and avoiding fragmentation in technologically augmented performance.

3.3.4.3 Quasi-Experiment: Cellist Positioning – *Inside vs. Outside the Spatial Field*

This quasi-experiment emerged following the finalisation of the electronic component of the piece, as a way of testing whether the physical position of the cellist — being within the spatial field rather than outside of it — made a perceptible difference to the performative coherence of the work.

We began with the first gesture on the opening page[79]. At this point in the piece, the electronic component is relatively subtle: a spatial crescendo of the amplified sound of the Baroque cello, projected either forward or backward within the quadraphonic field via a real-time expression pedal that I operate during performance. My intention was to modulate the sense of gesture by extending it into space, beginning from the instrument's pure acoustic tone. For this first trial, I was positioned outside the spatial field — following the standard model, with the audience at the centre and the loudspeakers encircling them. The result was immediately surprising: *"I couldn't hear anything."* Marta, who remained inside the spatial field, confirmed that the electronics were working correctly: *"The electronics are there, as intended",* but she added: *"The sense of progressive connection between the cello's sound and its spatial projection is completely lost."*

We then moved on to the first section of the second page, where the electronic material is contrasting. Again, I remained outside the field. While I was able to perceive some form of movement, I had no sense of its structure or positioning: *"*It felt like a single large mass — no edges, no perceivable source, no spatial form.*"*

These two contrasting experiences led us to some preliminary conclusions. Marta summed it up clearly: "Everything changes if the cellist is outside the space. The continuity of the gesture is broken — even visually. The performer appears isolated on stage, and paradoxically, the sound of the cello — though more visible — is muffled by the four sound sources closer to the audience." From my side, the feeling was equally clear: "After having already played within the quadraphonic field, being outside becomes a musically frustrating experience, almost counterintuitive. While playing, I kept imagining how the electronics would sound if I were inside the field, anticipating possible reactions that I, in fact, couldn't hear. The gesture became, in part, idealized."

The idea of delegating the operation of the spatialization to an acousmatic performer could be considered, but it doesn't solve the underlying problem: "There remains a perceptual imbalance between the close, detailed sound of the cello — which is, after all, the origin of the musical gesture — and the immersive diffusion of the electronics. Even with technical compromises, the final result is dictated by the electronics, which the cellist can no longer hear or shape." This loss of control, in my view, compromises the integrity of mixed music as a form of chamber music: "When the performer no longer has full access to the sonic result, the tacit agreement at the heart of chamber practice is lost. One becomes subject to an imposed hierarchy, in which the acoustic gesture is absorbed by a system that surpasses it."

The image Marta proposed summed this issue in almost caricatural terms: "It's like composing a piece for solo cello accompanied by a trombone quartet — but with the trombones positioned around the audience and the cello distant, off-stage. No one would do that. It would be impossible to balance, even if the trombones played pianissimo. It makes no sense to write a mixed music piece claiming to be chamber music, and to defend real-time spatialized electronics as an expressive resource (and therefore a

[79] See score here: *link*

possibility for interaction or response for the performer), if the performer can't hear the electronics in their full splendor."

3.3.4.3.1 Conclusion of the Experiment

The comparison between the two positions revealed clear differences. Within the quadraphonic field, the cellist felt a direct connection between gesture and spatial response: the effects controlled by the pedal were audible and reactive, allowing for expressive decisions in real time. Outside that field, the experience changed drastically — The spatialized sound, once interactive, turned into a "diffuse mass", without contour or perceptible origin. This loss of auditory feedback compromised gestural integration and weakened the performer's active role in shaping the sonic outcome.

Then, we concluded that the cellist's physical presence within the quadraphonic field is not only desirable, **but necessary** to ensure the performative coherence, expressive reactivity, and artistic integrity of this piece.

3.3.5 **Expert Feedback:** On the Accessibility of the Electronic Component

In order to critically assess the long-term sustainability and accessibility of the electronic system developed in this piece — particularly in relation to its usability by performers who did not take part in its creation — I sought feedback from composer Carlos Caires[80]. A specialist in electroacoustic composition and digital tools for performance, Caires is the author of IRIN[81], a micromontage software in Max software environment. His expertise made him a particularly suitable figure for evaluating the system proposed here.[82]

3.3.5.1 Technical Accessibility and Interface Choices

On the question of accessibility for non-specialist performers — namely, whether the interfaces of the system should be simplified to facilitate its adoption by performers without knowledge of real-time electronics or the Max-MSP software — Caires argued that this is "not a primary concern": "This type of music is normally played by specialised performers. Having a more complex pedalboard or even using sensors to capture performance gestures is now quite common — more so than people think." He considered the use of a dual pedal interface (Bluetooth event trigger + MIDI expression pedal) not only acceptable but "modest compared to many setups currently in use".

To support performer autonomy, however, he recommended that the patch include clear visual instructions and step-by-step guidance, particularly for performers unfamiliar with Max: "A truly accessible patch is one that is well explained — it needs to show every step, even how to connect the microphone, in plain text".

3.3.4.2 Performer Positioning and Monitoring Strategies

When presented with the rationale behind positioning the cellist within the spatialisation field, Caires responded positively, calling it "a great idea — we need more pieces that explore this kind of setup." He acknowledged the rarity of this configuration in current repertoire: "Tradition is very strong — even in more experimental contexts".

However, he stressed that this change would require enhanced monitoring strategies, to avoid disconnection between gesture and electronic response: "If the performer is inside the speaker field, they will need precise awareness of what is happening acoustically. Visual monitoring is essential — an iPad mirror of the mixer could help." He also suggested adapting electronic notation in the score,

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[80] **Note:** The feedback documented below was collected during an online meeting on April 4th 2025. The conversation was not recorded; the quotations have been reconstructed immediately after the meeting. They are presented here in good faith and without interpretative alteration, but have not been reviewed by the interviewee.
[81] See more here: *link*.
[82] For the full uncategorized feedback see Appendix 4- Third research cycle.

recommending the use of graphic fader symbols, a format commonly used in electroacoustic performance scores to represent dynamic control over effects.

3.3.4.3. Refinements to the Patch Structure

Caires proceeded to analyse the Max patch directly and made several practical suggestions to improve its adaptability and reliability across venues:

- He emphasised the importance of fine-tuning spatialisation distribution, particularly given the expressive role of space in this piece: “The way spatialisation is handled is critical here — it must be musically precise and available to be adjustable in every context”.

- He proposed the addition of a test mode within the patch, using a pre-recorded cello sample to allow for testing of all processing and routing configurations without the need for live performance. This, he argued, would be valuable for pre-concert room calibration and rehearsal logistics.

3.3.4.4 Conclusions From the Expert Feedback

The feedback from Carlos Caires confirmed the feasibility of the proposed model, emphasizing that the accessibility of a real-time electronic performance system does not depend on technical simplification, but rather on the clarity of its structure and documentation. The possibility of performer autonomy was validated, provided the patch includes clear textual instructions and intuitive visual interfaces. This perspective aligns with the model adopted in this project, which favors direct control by the performer without reliance on external agents, integrating technical complexity as a natural extension of specialized performance practice.

At the same time, the validation of the performer’s position within the quadraphonic field as an artistically relevant solution reinforces the potential of this approach as an original contribution to the practice of mixed music. The demand for new monitoring and notation strategies confirms that this configuration requires a reconfiguration of performance tools and gestures. The feedback received not only acknowledges the aesthetic relevance of this choice, but also offers practical pathways for its consolidation in future performances — strengthening the proposal of this piece as both a replicable artistic model and a technologically robust one.

3.3.6 Outcomes

This third research cycle culminated in the co-creation of the piece *Wolves and Wires* with Marta Domingues, for Baroque cello and real-time electronics. The final outcome — that included both the score for the cellist and the final Max patch of the electronics — reflects a triangulated process of development that consolidates:

- the findings and artistic decisions from each of the three creative residencies;
- self reflexions drawn from literature analysis;
- expert feedback from composer and software developer Carlos Caires.

Rather than being implemented as separate as an external element, interventions were embedded organically in the process, emerging from within the evolving creative practice. Each residency began where the last one ended, translating previous discoveries into new material or technical configurations. This constructive, building up method allowed for an ongoing musical refinement based on the relationships between musical gesture, spatialized space, and system design — always anchored in the embodied experience and autonomy of the performer. The resulting work proposes an integrated model for mixed music creation, in which artistic experimentation, technical innovation, and performance practice co-evolve in a performer-centred ecosystem.

At the conclusion of this cycle, a documentation package was produced that includes three elements: the performance score for the cellist, the final Max patch used in performance, and a stereo recording of *Wolves and Wires*. The recording offers a concrete aural trace of one realisation of the piece and supports the discussion developed in this chapter. However, because the work is conceived around spatial immersion as a central expressive element, this stereo document should be understood as a reduced version of the live experience, which cannot fully convey the spatial and perceptual dimensions of the performance.

FINAL OUTCOMES

Recording of the piece: *LINK*

Score (final version): *LINK*

Performance patch (Max-MSP):*LINK*

These materials constitute the only formats capable of accurately preserving the technical, structural, and interpretive conditions that define the artistic model proposed here — a system in which gesture, space, and control function as a single, indivisible whole.

3.3.7 **Research Cycle 3:** Conclusions

The core conceptual aim of this cycle was to rethink the performer's role in mixed music through embodied autonomy. Rather than operating electronics as a detached extension, the performer was repositioned at the centre of the spatial field and given full real-time control over the system. This shift required new gestural strategies, heightened sensitivity, and reconfigured attention, but preserved the expressive fluidity of performance.

These developments are deeply rooted in the initial conceptual framework defined during the first residency: the performer as a "receiver/reactor", attuned to gesture, sound production, instrumental materiality, space, and electronics. These five relational axes guided the entire cycle and shaped every decision — from timbral exploration on gut strings to spatial positioning and system design. The physical sensitivity required to interact with the Baroque cello became both metaphor and method for the broader principle of embodied listening and response.

Each residency functioned not merely as a working session, but as a recursive laboratory for practice-led experimentation. Findings from one phase were not archived but actively transformed into the starting point of the next. In this way, interventions emerged organically, becoming inseparable from the artistic and technical development of the piece.

This constructive method culminated in an ecosystemic performance model, in which gesture, space, and technology interact in reciprocal and responsive ways. The performer no longer stands outside the system of electronics but coexists with it, shaping (through the two established control interfaces) and being shaped by its real-time behaviour.

The feedback from Carlos Caires not only validated this model's artistic integrity but added valuable insights into its long-term usability, reinforcing the idea that accessibility in performance systems stems not from simplification, but from clarity in explaining the performative logic of the Max patch.

4 Research findings and outcomes

4.1 Documentation and explanation of the research outcomes

The final outcomes of this research reflect a multi-phase artistic inquiry that developed from the interpretative practice of an existing repertoire (the first movement of *Près*, by Kaija Saariaho) to the collaborative creation of a new work for Baroque cello and real-time electronics (*Wolves and Wires,* by Marta Domingues).

These two artistic outcomes — one reinterpreted, the other newly composed — emerged from iterative research cycles that addressed distinct but interconnected aspects of the central research question:

How can the embodied exploration of Kaija Saariaho's Près inform the development of new artistic models for performer autonomy in mixed music with live electronics, from the perspective of the cellist as both interpreter and system operator?

What follows is a detailed documentation and explanation of each of these artistic outcomes, outlining how they materialise the knowledge gained throughout the research and how they contribute to new practices in the field of performer-technology interaction.

4.1.1 Performance of Existing Repertoire: 1st movement of *Près* (1992), by Kaija Saariaho

AV File (Final Intervention Recording)

- **Piece:** *Près* (1992) by Kaija Saariaho
- **Performer(s):** Pedro Carmo (cello & electronics), Eva Aguilar (electroacoustic performer)
- **Date/Location:** 06-09-2023, Lisbon, OCP Headquarters
- **Duration:** 7'16'
- **Video Link:** [LINK]

Explanatory Notes:
This outcome marks the culmination of the first two research cycles, which focused on developing an autonomous interpretative approach to this seminal work in the mixed music repertoire. The final performance is the result of a practice-based exploration that includes:

- A detailed investigation of bowing techniques (sul ponticello, overpressures, contact point transitions), with special attention to the expressive precision required by the composer's notation;

- A technical and musical analysis of the original Max patch by Jean-Baptiste Barrière, including systematic testing of the quadraphonic spatialisation setup and individual output channels;

- The development of performer autonomy in operating the electronics — from integrating Bluetooth pedals to fully understanding the signal routing and logic of the patch;

- The experience of performing in different configurations (solo and with an electroacoustic performer), allowing for a critical reflection on interactivity models and gestural fluidity in live performance.

This process, by approaching performance from a holistic perspective, led me to a reflection on the relationship between cello and electronics as a responsive chamber-like dialogue — that I conceived from the rehearsal phase onward, and in which both technical control and expressive freedom reside in the hands of the performer.

4.1.2. Composition of *Wolves and Wires* (2025), by Marta Domingues

AV File: *Wolves and Wires Recording / Process Documentation Only*[83]

- **Piece:** *Wolves and Wires* (2025) by Marta Domingues
- **Line-up:** Baroque cello and real-time electronics
- **Performer(s):** Pedro do Carmo (cello & electronics)
- **Date/Location:** 24-05-2025, at Lisboa Incomum
- **Duration:** 1'01'
- **Video Link:** [LINK]

Final Score: [LINK]
Max Patch (final version): [LINK]

Explanatory Notes:
This piece represents the culmination of a practical research journey that began with the in-depth analysis and performance of *Près* by Kaija Saariaho. Many of the artistic and performative concepts explored there — such as the importance of collaborative compositional processes, the awareness of spatial electronics as an expressive element, and the need for informed and autonomous control of the technology involved — were here reconfigured within a collaborative creation context, giving rise to a different performative model.

[83] **Note:** No definitive recording of the piece is provided, as the spatial nature of the piece — where sound diffusion and gesture are interdependent — cannot be captured at all in stereo formats. This recording serves only as process documentation. The final outcomes which preserve the performative and structural logic of the work are the Final Score and the Max patch (final version).

The piece was developed over the course of three artistic residencies with composer Marta Domingues, through an iterative process of experimentation and composition that resulted in a *performer-centered* approach to mixed music. The main pillars of this process include:

- The positioning of the cello at the centre of the quadraphonic sound field, proposing a listening and spatialisation model anchored in the performer's body, within a performative ecosystem where gesture, sound and space become expressly interdependent;

- The creation of interfaces tailored to support performative autonomy, such as a mapped Bluetooth footswitch and expression pedal, visual monitoring systems, and an ergonomically organised stage setup, enabling the performer to operate the entire electronic system independently and fluidly;

- The collaborative construction of the Max-MSP patch, articulated with principles of spatialisation, gestural control, and auditory feedback, all centred on the physical experience of the performer;

- The progressive integration of feedback gathered through critical literature review and the practical suggestions of composer and programmer Carlos Caires, which contributed to greater clarity in documentation, system usability, and monitoring strategies;

As such, the piece puts forward a model of mixed performance practice in which the performer's body not only reacts, but also commands, configures, and shapes sound and space — in articulation with the system and the composition — through a form of autonomy that is at once technical, expressive, and artistic.

Together, these two outcomes outline a coherent artistic trajectory — one that begins with critical reinterpretation of existing repertoire and culminates in the creation of a new work. At its core is a progressive redefinition of the performer's role in mixed music: from interpreter to co-creator, from reactive agent to autonomous system operator. Grounded in embodied practice and technological fluency, this trajectory puts forward a performer-centred model of creation and performance in mixed music — one where interpretative insight, compositional collaboration and system control emerge as interconnected dimensions of artistic autonomy.

4.2 Self-assessment of the research outcomes and expert feedback

This research produced two artistic outcomes: a final performance of the first movement of *Près* by Kaija Saariaho and the creation of *Wolves and Wires* (2025), a new work for baroque cello and live electronics. These outcomes emerged from a continuous investigation of performer autonomy, shaped through research in cello extended techniques, spatial awareness, and system interaction.

Artistic Choices

The final performance of *Près* demonstrated a clear shift from traditional execution toward a more autonomous, chamber-like interaction with the electronics. Through precise control of spatialisation, sound processing, and phrasing the electronics became a responsive partner rather than a fixed layer. This was especially noticeable in the collaborative performance with Eva Aguilar, where the flexibility in shaping dynamics and timing extended the expressive possibilities of the piece.

In *Wolves and Wires*, this intention was developed further than originally envisioned. Inspired by the expressive priorities in *Près* — including spatialisation and electronics as extensions of instrumental gesture — the new piece placed the performer inside the speaker field. This spatial repositioning made the electronics audibly responsive to gesture, enhancing the chamber-like interaction and integrating spatialisation into the performer's expressive vocabulary.

The choice of baroque cello — beyond the timbral and expressive qualities of gut strings mentioned before — was conceived also as a kind of "homage" to historical performance practices. In Baroque settings, concerts often took place in rather small rooms/chambers, with musicians positioned in the center, among the audience. Instrumental sound projection was not a central concern. This historical logic inspired the spatial configuration of *Wolves and Wires*: proximity over projection, immersion over directionality. These ideas shaped not only the setup of the piece, but also decisions around physical gesture, material articulation, and the relationship between sound and space.

Limitations and Accessibility

Alongside the artistic definitions, the project also exposed some concrete limitations — especially in relation to hardware. In mixed-music, where the details in the sound of the electronics is very refined and blending is crucial, the quality and balance of the loudspeakers proved to be a key factor. Lower-quality or uneven speaker setups reduced clarity in the electronic part and weakened its integration with the acoustic instrument. This raised a practical but essential question: what type of PA system best supports this kind of music, particularly in non-specialised venues?

Another limitation concerns accessibility. The system created with Marta Domingues prioritised performer fluency and expressive control but was not designed as a transferable model to different musical contexts. While its Max-patch and score were later revised for usability, the infrastructure — involving a

quadrophonic setup, DPA microphone[84], audio interface, Bluetooth and expression pedals — remains a technical and financial barrier for many classically trained performers.

Collaboration and Expert Feedback

Collaboration played a critical role throughout this research. Working with Eva Aguilar (Cycle 2) showed the musical possibilities of distributed control and phrase shaping of the electronic possibilities. In *Wolves and Wires*, co-creation with Marta Domingues extended this dialogue into composition, allowing performance constraints and gestural affordances to inform the structure of the piece itself.

Feedback from teachers and experts shaped the process at multiple stages. Jeroen den Herder's input early on helped refine extended techniques on the cello and introduced the use of gut strings — a choice that became central in Cycle 3. René Uijlenhoet supported the technical realisation of spatialisation and helped test speaker setups and interface configurations. Carlos Caires provided both artistic validation of the interaction model and practical recommendations for the Max patch, especially in relation to spatialisation mapping and interface usability.

[84] While not mentioned in this report, the choice of microphone proved essential. The DPA 4099 for cello (link) ensured stable amplification without feedback, a critical factor when performing within the quadraphonic sound field.

4.3 Conclusion

This research set out to rethink the role of the performer in mixed music — not as a reactive player executing pre-defined gestures, but as an agent capable of shaping systems from within. Through three research cycles, the project traced a progressive expansion of the performer's role: from interpretative exploration of the cello part in *Près* (Cycle 1), to shared responsibility in a collaborative performance context (Cycle 2), to the co-creation of a new work in which performer, system, and space form an integrated ecosystem (*Wolves and Wires*, Cycle 3).

The key outcomes reflect a gradual but decisive shift: from a performer operating alongside the electronics to one acting within and upon them. This shift is not merely technical, but conceptual — and it was grounded in embodied musical practice. Whether through repositioning the performer inside the speaker field or developing gestural control interfaces, the central goal remained consistent: to reclaim musical agency in contexts where technology is often perceived as an external constraint.

This process also revealed how performer autonomy depends on more than access to controls. It requires a fluency with the system's behaviour, a spatial awareness of how sound functions in real time, and the ability to make interpretative decisions that integrate all layers of the musical environment. In that sense, autonomy is not fixed or guaranteed — it is negotiated through experience, feedback, rehearsal, and context.

Equally, the research showed that new artistic models for mixed music do not emerge in isolation. They grow through collaboration — with composers, programmers, and peers — and through the critical reassessment of inherited performance models. The performer-centred approach that resulted from this project was not created as a replicable system, but it does offer insights that may be relevant to others navigating similar challenges, whether as performers, composers, or educators.

At its core, this research reinforces a position already present in the literature on mixed music: that interpretation is no longer only about fidelity to the score, but about dialogue — between gesture and system, space and sound, structure and intuition. What this project adds is a situated, practice-based articulation of that position, rooted in the perspective of the performer as both interpreter and system operator.

Rather than proposing a fixed model, this research puts forward a situated artistic configuration — one developed through embodied practice, technical experimentation, and collaborative dialogue. By repositioning the performer within the spatial field, designing responsive systems for gestural control, and drawing configurations reminiscent of the intimacy of historical chamber settings, the project reimagines the performance of mixed music as a site of real-time dialogue — not only between instrument and electronics, but between body, space, and sound. While this configuration was not designed for universal application, it may function as a model-in-practice: one that foregrounds autonomy, proximity, and responsiveness as foundational artistic conditions. Its relevance lies not in its transferability, but in the way it demonstrates that performer agency can be shaped — not by control alone, but by the creation of conditions in which the performer listens, reacts, and co-authors the musical experience from within the artistic process.

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6 Network

Cellist:

- **Decharmes, Alexis**- is an active ambassador of numerous cello repertoires. Born in 1977 and trained at the Paris Conservatoire, he studied with Michel Strauss and Philippe Muller. He joined in 1998 the Ensemble Court-circuit, collaborating regularly with IRCAM and with the Ensemble Intercontemporain. In 2006 he joined the orchestra of the Opéra national de Paris, while pursuing a sustained activity in contemporary music.

- **den Herder, Jeroen** - After finishing the musical academies of Zwolle and Amsterdam in The Netherlands he completed his cello studies in London. His teaching career started at the Utrecht Conservatory, and at present, he is teaching the cello majors at the Amsterdam and Rotterdam Academies.

- **Karttunen, Annsi**: Karttunen's repertoire ranges from the early baroque to living composers and improvisation. He is a long time collaborator of Kaija Saariaho, being present in most of the process of composition, and premièred most of her cello pieces. All of Saariaho's pieces for cello are dedicated to him.

Composers:

- **Aguilar, Eva** - Eva Aguilar is a Portuguese composer and performer based in The Netherlands, where she is pursuing postgraduate studies at the Institute of Sonology in The Hague. Her work spans composition, improvisation, and interdisciplinary performance, often integrating movement, voice, and electroacoustic media. She has collaborated with ensembles such as Plus-Minus (UK), GRAME (FR), and Divertimento Ensemble (IT), and her work has been featured at festivals and venues across Europe, including BoCA, MIXTUR, and the Calouste Gulbenkian Foundation.

- **Barrière, Jean-Baptiste** - Jean-Baptiste Barrière is a Paris-born composer and multimedia artist. He has a background in music, philosophy, and art history. Barrière worked at IRCAM, contributing to projects and later becoming Director of Creation. He has composed music for performances, installations, and virtual reality experiences, showcasing his expertise and creativity.

- **Caires, Carlos** - Carlos Caires is a Portuguese composer and researcher whose work bridges electroacoustic composition and digital tool development. He studied in Lisbon and Paris,

completing a doctorate under Horacio Vaggione, and has presented his music at festivals in Europe and Asia, including Berliner Festspiele, Música Viva, and the Shanghai International Electroacoustic Week. His works have received awards such as the Joly Braga Santos Prize and the ACARTE Prize. He is the creator of IRIN, a software for micromontage developed between CICM–Paris 8 and CITAR, and currently teaches at the Lisbon School of Music.

- **Domingues, Marta** - is a Portuguese composer whose work explores the intersections between acousmatic and instrumental practices. Her music — performed across Europe at festivals such as Música Viva, Sonorities (Belfast), L'Espace du Son (Brussels), and Young Euro Classic (Berlin) — has received recognition from institutions including the Métamorphoses competition, CIME/ICEM, and the Annette Vande Gorne Foundation. She studied composition at the Lisbon School of Music and continues her research into gesture and spatiality through real-time electronics and collaborative creation.

- **Saariaho, Kaija** - Kaija Saariaho is a Finnish composer based in Paris. During the course of her career, Saariaho has received commissions from the Lincoln Center for the Kronos Quartet and from IRCAM for the Ensemble Intercontemporain, the BBC, the New York Philharmonic, the Salzburg Music Festival, the Théâtre du Châtelet in Paris, and the Finnish National Opera, among others. In a 2019 composers' poll by BBC Music Magazine, Saariaho was ranked the greatest living composer.

- **Uijlenhoet, René** - Dutch composer and teacher known for his electronic music and live electronics works. He studied with Ton Bruynèl, Theo Teunissen, and Jan Welmers. Uijlenhoet has taught electronic music and computer composition in the Utrecht Conservatory, being a teacher at Codarts Rotterdam. He composes works for tape, live electronics, traditional instruments, ballet, and theater.

7 Appendices

7.1 Appendix 1: List of all self-produced AV media included in report[85]

7.1.1 First research cycle

Reference Recordings

- 01
- 02

Data Collection

- **Quasi Experiment 1:**
  - Step 1
  - Step 2
  - Step 3
- **Quasi Experiment 2:**
  - Ex. 1
  - Ex. 2
- **Quasi Experiment 3:**
  - 01
- **Quasi Experiment 4:**
  - 01
  - 02
  - 03
- **Click-Track:**
  - 01
  - 02
  - 03
- **Foot Pedal:**
  - 01
  - 02

[85] Check the complete folder here: *link*

7.1.2 Second research cycle

- Reference Recording:
    - 01
- Interventions:
    - 01
    - 02
- Outcomes:
    - 01
    - 02

7.1.3 Third research cycle

Residency 01- Timbrical Experiments

- 01
- 02
- 03
- 04

Intervention Recordings

- 03
- 04

7.2 Appendix 2: Critical media review

1. “The Liberation of Sound”, by Edgar Varèse

Edgard Varèse (1883-1965) was a French-born composer and musician who is widely considered one of the most important figures in the development of electronic and experimental music. He is best known for his use of unconventional instruments and electronic sound manipulation, which he used to create bold, innovative compositions that challenged the traditional boundaries of music. Throughout his life, Varèse was a vocal advocate for the liberation of sound, arguing that music should be a free and dynamic art form that reflects the diversity and complexity of the world.

"The Liberation of Sound" is a seminal essay in the history of contemporary classical music, in which Varèse outlines his radical ideas about the potential of music to break away from traditional tonal and rhythmic structures and explore new sonic territories. The essay is significant because it anticipates many of the ideas that would come to define the avant-garde movements of the mid-20th century, including electronic music and sound as a raw material.

Varèse's advocacy for electronic instruments and technology highlights his forward-thinking approach to music composition. By using technology to expand the possibilities of sound and create new timbres and textures, Varèse's ideas helped pave the way for the development of electronic music in the following decades.

However, some critics have argued that Varèse's ideas about the liberation of sound were overly abstract and disconnected from the emotional or expressive aspects of music. The music critic Harold Schonberg accused Varèse of being "obsessed with novelty for its own sake" and of "trivializing the most profound art that man has created."

Others have argued that Varèse's music is often difficult to engage with, particularly for listeners who are not familiar with the avant-garde tradition. The music critic Alex Ross has noted that Varèse's music "can seem forbidding and strange to ears accustomed to more familiar sounds and structures."

Despite criticisms of his ideas and music, "The Liberation of Sound" remains a groundbreaking and influential text in the history of contemporary classical music. Varèse's visionary approach to music composition has had a lasting impact on avant-garde music in the 20th and 21st centuries, influencing generations of composers and performers.

Varèse's advocacy for electronic music and technology was particularly important in the development of the electronic music genre, which has become an essential component of contemporary music. His emphasis on the use of technology to explore new sonic possibilities and to expand the expressive potential of music continues to influence composers today.

Furthermore, Varèse's ideas about the liberation of sound also played a key role in the development of spectral music and post-spectralism (where Kaija Saariaho is included), as well as the exploration of extended instrumental techniques and sound design.

2. "Instrumentalists on Solo Works with Live Electronics - Towards a Contemporary Form of Chamber Music?" by François-Xavier Féron and Guillaume Boutard

The study conducted by François-Xavier Féron and Guillaume Boutard explores the expertise of instrumentalists performing musique mixte with live electronics. Their research focuses on the processes of apperception, appropriation, and interaction between instrumentalists and live-electronics, considering

both sociological and musicological perspectives. By analyzing instrumentalists' discourses, the authors aim to conceptualize the key factors involved in the performance practice of solo works of musique mixte with live electronics and if it could be accepted as a form of chamber music.
The authors discuss the importance of sociological and musicological perspectives in understanding the interpretation and performance of musique mixte. They highlight the complexity of the relationship between instrumentalists and live electronics, emphasizing the appropriation process and the convergence of contemporary music with chamber music. While traditional chamber music involves interaction among multiple instrumentalists, solo works with live electronics present a different type of interaction. Nonetheless, these solo pieces can still be considered part of the chamber music repertoire, as they combine acoustic instruments with tape or live electronics, leading to a new direction in the genre.
The authors note that solo instrumentalists collaborating with electronic partners must establish a close relationship to develop the sound and interaction between them, being identified as the same relationship that one has with a pianist when playing a sonata. Such collaboration requires working with partners who possess their own musical sensibilities and knowledge.
The authors interviewed instrumentalists who unanimously compared the rehearsing process and performance of solo works with live electronics to that of taking place in classical chamber music ensembles.
Furthermore, the authors discuss the differences between instrumental chamber music pieces and solo works with live electronics in terms of production context.
Historically, concert halls lacked proper playback and amplification equipment for music with tape. However, technological advancements have mitigated these issues. Nonetheless, the technological environment remains a challenge for the practice of musique mixte. The authors emphasize the critical modifications in rehearsal processes and relationships with partners, as instrumentalists now collaborate with individuals ranging from live electronic musicians to composers and sound engineers. The partners ensure the proper projection and interaction of the electronic segment with the instrumental sound, acting as the instrumentalist's ears in the audience.
Additionally, the authors address the issue of notation in the score for electronics, which is often approximate or even nonexistent. Consequently, the perception of electronics primarily relies on ear-based work. Therefore, instrumentalists need to rehearse adequately with their partners in suitable studios and concert halls to achieve a cohesive performance.
In conclusion, Féron and Boutard's study provides valuable insights into the performance dynamics and challenges faced by instrumentalists in solo works with live electronics. By examining the intersection of sociological and musicological perspectives, the authors contribute to a comprehensive understanding of the genre. The conceptualization of factors influencing the production process and the comparison to chamber music expand the knowledge of the genre's complexity.
The authors effectively emphasize the importance of collaboration and the development of close relationships between instrumentalists and electronic partners. This collaborative effort ensures the refinement of sound interaction and highlights the significance of interplay within the performance.

3. “Performing electroacoustic music: a wider view of interactivity”, Elizabeth McNutt

Elizabeth McNutt, an esteemed flutist, is deeply dedicated to contemporary and electroacoustic music, embodying a great interest for the music of today. Recognized internationally for her virtuosic performances, she has collaborated with renowned figures in the field, including Pierre Boulez, Harvey Sollberger, and Roger Reynolds, among others. With a vast repertoire of premieres and performances

across Europe, Asia, and the United States, McNutt has established herself as a leading exponent of innovative and cutting-edge musical compositions.

Her article “Performing electroacoustic music: a wider view of interactivity” offers valuable insights into the challenges faced by performers when collaborating with composers who incorporate electronics in their compositions. It effectively highlights the unique aspects of electroacoustic performance from the performer's perspective. The article emphasizes the presence of “prosthetic elements” introduced by electronic devices and the complications they bring to the practice of the performer's art, such as the use of microphones or foot pedals. It acknowledges the disparities between performers and electroacoustic composers, pointing out that issues which may seem obvious to performers often go unnoticed by composers and vice versa.

One significant challenge discussed in the article is the issue of disembodied sound. Performers often encounter difficulties when interacting with common technologies like microphones and loudspeakers. The use of loudspeakers distances sounds from their source, creating a disconnect between the performer, the space, and the sound source. Performers are accustomed to physically adapting to the acoustics of the room, but electroacoustic composers imagine music within the fixed and artificial space of loudspeaker diffusion. This contrast in approach can be contradictory and impact the performer's physical and sonic identity. Amplification, while enhancing sound blend and balance, introduces additional challenges such as projecting "private" and normally inaudible sounds. The presence of internal microphones, pickups, and cables can also affect the instrument's weight, balance, and the performer's mobility.

To address these challenges, the article emphasizes the importance of a strong and trusting relationship between performers and sound engineers. Effective communication and collaboration are crucial, especially during sound checks and rehearsals. Ensuring proper tonal balance, projection, and the ability for the performer to hear everything they need to interact with are essential during sound checks. Scheduling enough time for rehearsals, documenting the stage setup accurately, and involving performers in the early stages of testing new instruments or technologies can significantly improve the overall performance experience.

The article also discusses the concept of "invisible partners" in live electroacoustic performance. It points out that regardless of whether a composition involves interactive computers or fixed accompaniment, performers perceive the interactions as real-time interactions between instrumentalists, instruments, electronics, and audiences. However, traditional forms of human interaction such as physical cues, eye contact, and breathing together are not possible in this context. Sound becomes the primary measure of correlation, although it remains disembodied.

The article further explores the challenges posed by compositions with fixed accompaniment, where performers are responsible for coordinating with the pre-recorded electronic parts. This dynamic can be limiting, as the performer must maintain focus on keeping the ensemble together, thereby emphasizing their role as a prisoner of the fixed accompaniment. The article highlights two coordination strategies: fluid and rigid. While fluid coordination allows for some freedom and illusion of interaction, it is ultimately limited. On the other hand, rigid coordination provides a more precise interaction but can create a prison of perfection, requiring mechanical accuracy from the performer.

The article acknowledges that one approach to addressing the challenges of electroacoustic performance is the use of automated score-following systems. This technique empowers the performer to shape and phrase the music, providing them with a greater sense of control and allowing for a more expressive performance. The author highlights compositions that employ this strategy, including Kaija Saariaho's "NoaNoa" (1992) and Andrew May's "The Twittering Machine" (1995). In these pieces, overlapping layers of signal processing and sound file playback create a seamless and elegant texture that remains responsive to the performer's manipulation of time.

However, the article also raises concerns regarding the use of pitch-tracking algorithms in score-following systems. Variations in acoustics, instruments, performers, and specific performances can introduce inaccuracies into the tracking process. This presents a challenge in achieving a delicate balance between musicality, interpretation, and the demands of maintaining accuracy. The performer may be required to deliver a mechanically flawless performance to ensure the proper functioning of the score follower, potentially compromising their artistic expression and freedom.

In conclusion, the article provides valuable insights into the challenges faced by performers in electroacoustic performance. It emphasizes the need for collaboration, effective communication, and mutual understanding between performers and composers. By shedding light on the specific challenges related to prosthetic elements, new instruments, and the concept of invisible partners, the article prompts performers and composers to critically reflect on their approaches to electroacoustic performance.

4. "Performance Practice Issues in Electronic and Interactive Systems", Mari Kimura

Mari Kimura's article on "Performance Practice Issues in Electronic and Interactive Systems" provides an insightful exploration of the challenges and considerations involved in incorporating technology into live music performances. As a performer, composer, and educator in the realm of interactive computer music, Kimura shares her experiences and perspectives, offering valuable insights into system aspects, pragmatic programming, and the creative process. This critical review aims to evaluate the strengths and weaknesses of the article while highlighting its contributions to the field.

The article demonstrates a deep understanding of the intricacies of incorporating electronic elements seamlessly into traditional performance settings. One notable strength is her emphasis on creating a "one-touch" system that minimizes the need for direct computer interaction during a live performance. By focusing on simplicity and fluidity, Kimura effectively conveys the idea that technology is just one tool among many for musical expression. This approach aligns with her intention to maintain the performer's connection with the audience and avoid unnecessary distractions.

The author's decision to eschew foot pedals in interactive performances adds to the coherence and continuity of her musical expression. Kimura argues that relying on foot pedals can introduce unnatural physical movements and disrupt the audience's visual engagement. Her viewpoint aligns with the belief that performance practice should prioritize the seamless integration of technology with the musician's artistry. Furthermore, she draws on the insights of George Lewis to support her argument against the use of foot pedals, highlighting the impact of these devices on performer-computer communication and improvisational flexibility.

Kimura's stance against relying on technical assistance during live performances reflects her commitment to maintaining independence and artistic control. She acknowledges the potential benefits of having a second person operate the computer but argues that it detracts from the essence of a true duo performance between the musician and the technology. By assuming the roles of both performer and interpreter, she ensures a cohesive and reliable musical experience, aligning the computer's behavior with her own timing and musical intentions.

The article also addresses the technical challenges associated with interactive performances. Kimura's innovative solution of using a Flexible Time Window showcases her meticulous attention to detail and her commitment to robustness in her compositions. By employing overlapping intervals and trigger mechanisms, she creates a reliable system that allows for fluid transitions between different sections of a piece. This adaptive approach allows her to maintain control over the performance while accommodating potential technical hiccups. However, the author's admission of occasionally resorting to a

pre-programmed "cheat" version raises questions about the extent to which improvisation and spontaneity can be compromised in pursuit of reliability.

In conclusion, Mari Kimura's article on performance practice issues in electronic and interactive systems provides a valuable contribution to the field of computer music. Through her personal experiences and perspectives, she offers a thoughtful exploration of system aspects, pragmatic programming, and the creative process. By prioritizing simplicity, coherence, and independence, Kimura challenges traditional paradigms of incorporating technology into live performances. While her insights and innovative solutions are commendable, some questions remain regarding the balance between reliability and the artistic spontaneity that characterizes live performances.

7.3 Appendix 3: Full feedback on reference recordings

7.3.1 First Research Cycle

Excerpt of *Près*, for cello and live electronics

Feedback Overview

I asked for feedback from Jeroen den Herder, my main subject teacher, Lluïsa Paredes, a fellow student with some experience in contemporary music, and René Uijlenhoet, a composition and new media teacher at Codarts.

Jeoren referred to the significance of Saariaho's precise notation and bow technique in conveying her musical intentions. Specifically, he recommended exploring different bow techniques, such as heavily distorted Sul Ponticello and more scratchy overpressures. He also suggested experimenting with gut strings to achieve greater attention to contact points. These techniques, he explained, could help me convey the desired rawness of the piece.
Lluïsa highlighted the significance of the computer sounds in the piece, urging me to pay close attention to them and experiment with different textures and dynamics. She also emphasized the importance of maintaining the written tempo and rhythmic proportion, which could help provide greater musical consistency.

René said that when simulating the common practice of performing this type of repertoire (playing with the electronics only in a dress rehearsal or concert), the timing synchronization between the cello and the electronic part is considerably affected. He suggested that I could record again the excerpt using a footswitch to self-launch the electronic events in real-time during the performance. To do this, he recommended that I study the electronic part, using a Bluetooth pedal that I already use to turn pages. He also suggested the possibility of finding an assistant who could launch the electronics for me while I play.

My reflections on the reference recording can be provided on topics that have not yet been covered in the remaining feedback, namely the result of the integration with the electronics added afterwards which, despite not being "supposed", works as a kind of simulation of what would happen in a first rehearsal using technical support.
Just when I opened the software for the first time, after recording, I realized that there was an *infinite reverb*[86]. I was not at all aware of this effect, which is noticeable in my playing style (especially in the endings of phrases).
Another issue is the lack of awareness of the duration of each effect, which, although noted in the score, is easy for me to lose count of, with my tendency to drag (several times the effect had already ended, and I had not yet started the phrase that should be on top).

[86] An *infinite reverb* is a type of audio effect that creates the illusion of sound reflections persisting indefinitely. This is achieved by feeding the audio signal back into the reverb processor repeatedly, without applying any form of damping or filtering, resulting in a denser and more complex sound texture over time.

The rhythmic accuracy is also something that I noticed is not perfect and is undoubtedly one of the aspects that I will address in the continuation of my research.

Uncategorized Feedback

- **Feedback 1- Jeroen den Herder (main subject teacher)**

  Saariaho knows exactly what she wants, she is very precise with her notation. This is noticeable with her precise bow notation.

  - *Your Sul Ponticello should be really Sul Ponticello, very distorted.*
  - *The overpressures must be really scratched, don't be friendly! We are too used to training good quality and are often too polite regarding this music.*

  - *Sul tasto is not just a location, in this music also means a different care on bow speed!*

  - *I suggest you try to play this excerpt on gut strings. This type of music has some common aspects with baroque playing, regarding bow use and practice. Modern strings don't require the same care and consciousness for contact points that the gut needs, although this music is based on that type of attention.*

- **Feedback 2- Lluïsa Paredes (Codarts fellow student, plays contemporary music)**

- *Computer sounds may be extended*
- *Don´t forget, tempo is 54 bpm;*
- *Rhythmic proportion- don´t forget, she writes everything! It will give more musical consistency*
- *More pressure on over pressures*
- *Different characters: Try to find different nuances*

- **Feedback 3- Excerpt from transcription of the Interview with René Uijlenhoet (Codarts composition teacher)**

  René: I was impressed with the recording and the integration between your playing and the electronics, but also the way you give the expressions that she writes in the score. She writes really deep transitions. From very soft to very loud, from very ponticello to very whatever. And that is intended, to be dramatic and very engaging. That's what you give, so that's excellent.

  Pedro: Thank you.

René: I have a question. This piece comes with probably a Max patch. Did you operate by switching yourself *(the electronics*) through the preset or how did it work?

Pedro: For this recording, I decided to do what is usual, which is you don't have the experience with electronics as a performer, you just have the lucky opportunity to be with the equipment and play with electronics once, almost in the dress rehearsal for a concert. So that's basically what I did. I recorded acapella, and then I added myself the electronics after with the recording. I played the video into the max MSP patch, triggered the electronics live, and recorded the output.

René: So, you played the sound of your recording into the program that Barrière made.

Pedro: Yes, Into the max patch.

René: It is live electronics but in two passes. That's an excellent way of studying it.

Pedro: Yes. But doing that, Of course, I couldn't listen to electronics.

René: No, I think your timing was influenced here. The electronics happen around you, but nothing stops you from doing the performance again. And this time with the live electronics. And like you practiced the cello part, you can also practice the electronic part until you pull it off, playing both parts together. Or maybe you need an assistant, maybe one of the composers could be the performer of the electronics.
Do you also have a pedal that can stand it *(the triggering of the electronics)?*

Pedro: I have the possibility to have a Bluetooth pedal, used for page turning. That's nowadays very mainstream, something that you didn't have 20 years ago.

René: Exactly. That's a very nice solution, and it will be helpful for future students and future composers.

7.3.2 Second Research Cycle

Performance of *Près*, first movement (Reference Recording)

- **Self-feedback:**
    - *Good in general.*
    - *Cello playing confident and musically rich, although intonation still needs some work. Bow contact is not always secure.*
    - *The sound relationship between the cello and electronics is well balanced, sometimes missing a bit of reverb on certain moments. In general, the volume of the events is too*

loud compared to the volume of the reverb, causing a fragmented sound sequency, where sections become audible instead of a continuous path with some nuances.

Outcome: Comparison Recording (Self-Feedback)

Outcome Recording 01

- Excerpt 1

From the reference recording to the intervention recording 01, a notable improvement in the mastery of the instrumental part is evident, with more precise tuning and careful phrasing, displaying richness in different points of contact. In the second recording, the electronics are more pronounced, yet they do not overshadow the cello, as the balance between the two parts is well-executed. The balance between the components is clearly more successful in the intervention recording, allowing for a clear perception of electronic details, resulting in greater musical richness overall.

-Excerpt 2

The difference here is striking. In the reference recording, the electronic component is barely audible in this section, and the harmonizer is almost indiscernible. Of course, acoustic differences in the room, equipment disparities, and recording positioning must be taken into account. However, regarding timing and awareness of the electronic part, the intervention recording reveals a more thoughtful reflection and planning of the musical phrase management. Particularly in the phrase endings, there is a careful listening to the harmonizing of the electronics, creating the impression that the previously played material slowly dissolves in a fade-out. What comes afterward takes this into account, along with a more extended and planned pause between each phrase.

Outcome Recording 02

-Excerpt 1

Although it's challenging to compare parameters that are nearly impossible to measure in a stereo recording, there are still some considerable differences. A more intense and present electronic part is audible, prompting the cello to adjust its character to something less static and neutral, becoming more present and objective. There are echoes of spatialization from the second recording, particularly in the reverb effect at the end of phrases. In a way, the balance between various parameters of the electronic part is better achieved in the first recording (the sound files seemed too prominent in the second recording). On the other hand, the balance and integration of the electronic part as a whole with the instrument are better achieved in the second recording.

- Excerpt 2

The differences primarily concern the clarity in the electronic part. However, there's a question about whether everything might be too loud in the second recording. This is because the amplified sound of the cello is audible, which shouldn't happen. When this occurs, it indicates that everything should be a level lower. Of course, the recording positioning must be taken into account. The direction of the musical phrase was better achieved in the second recording, where the end of each intervention is more conscious and connected with the electronics. The last 6 measures of the piece, transitioning from a long note to tremolo, were less rushed in the first recording, offering listeners a better understanding of the interaction between electronics and cello. This also provides more time for the sound effect of ocean waves to develop over time, resulting in a more musically rich experience.

7.4 Appendix 4: Transcription of interviews

7.4.1 First Research Cycle

Interview 1- René Uijlenhoet

You are a composer with a diverse background in electronic music, using a wide range of compositional techniques with electronics, from fixed support to live transformations. I'm curious about your thoughts on the different uses of electronics and how they affect the musical outcome.

- **Full Interview:** ***Audio file***

- **Original Script:**

1) As a cellist with experience in contemporary music, I have noticed a resistance among classical musicians towards music for their instruments that incorporates electronics. Even some great performers have trouble understanding how to approach this type of music. What do you think contributes to this resistance and lack of understanding?

2) In what ways do you think live-electronics in mixed music challenges conventional ideas of performance?

3) I can imagine that you have done a lot of technical support for mixed-music concerts. Can you notice when an acoustic performer is not totally aware of the electronic part?

4) How do you advise acoustic performers to gain consciousness of the electronics in their interpretation, in a composition like "Près" by Kaija Saariaho? Would it be if they had some technical awareness to the process, such as notions of digital sound synthesis and transformation and an understanding of the importance of the microphone?

5) How should a performer analyze "Près", so that would contribute to an informed interpretation of the piece, specifically in regards to the interaction between cello and electronics?

6) What do you believe could attract more performers to embrace and play this type of music?

7.4.2 Second Research Cycle

Questionnaire 1- Eva Aguilar (composer)

1. **In your opinion, what should be the role of the electroacoustic performer during rehearsals and the performance of a mixed music piece?**

   The electroacoustic performer should be active as any other musician, listening and engaging with sound at distance, and sharing ideas with the other players - being present and reactive at the moment of the performance as much as possible and anticipating next procedures or technical actions as long as accompanied by expressive musical meaning.

2. **The rehearsal of the piece *Près* for the concert on the 6th of September 2023 was much more than the typical "technical soundcheck," providing room for collaborative musical experimentation. How would you describe your experience, from an interpretative point of view?**

   Balancing volume and other effect parameters according to Kaija Saariaho's indications on the score, as well as following my compositional approach intuitively in dialogue with Pedro's vision of the piece. As both composer and cellist, me and Pedro sometimes even switched places at rehearsal in order to get the sense of both sides, for interpretation and soundcheck matters.

3. **Being the relationship with space one of the main compositional explorations of the piece, how did the acoustics of the concert room affect the musical choices mentioned in the previous question?**

   Many interpretative decisions for the electronics in real time were taken based on the acoustics of the room, for instance:
   the amount of amplification needed in order not to cover the acoustic of the instrument, microphone settings/placement, and variations on how wet/dry I would determine an effect and its levels, whether being a harmonizer, different types of delay, space-filtering, transposition techniques, reverb, resonant filters, pre- recorded cello transformed sounds and sampled sea waves.

4. **How would you describe the performance of *Près* at the concert, both technically and artistically?**

   Some factors as a rider with not too complex technical requirements and the simple and clear MAX patch and user-friendly MIRA extension, operated via IPad as a controller, were a fundamental key to make this piece and electronics interaction work very quickly and good. During the performance of Près I was constantly paying attention to all events triggered (sound files or effect changes) by Pedro, who was using a pedal and was also explicitly reacting to the electronics when holding an action on the cello until the computer sound was finished. I tried to make evident all instructions given by Kaija Saariaho on electronics and oriented my efforts to

enhance electronic dynamics on the score, connecting to the cello in a chamber music setting/manner.

5. **Does the ultimate performance of mixed music pieces require the presence of an electroacoustic performer? Or should the instrumentalist take on this role if their technical proficiency allows it?**

   Not necessarily. I believe that decision should be taken in case by case, favouring the most organic option to better transmit the musical ideas behind the piece, to the audience. If the instrumentalist finds it stimulating to operate the electronics on stage at the same time, it is perfectly possible as long as he/she has the music technology knowledge, of course. Nevertheless, I would also say that you can take many artistic benefits from a collaborative experience as this one, enriching your thoughts on interaction when working together with other musicians since it is needed quality time for both performers to make textures fuse well between the instrument part and the electronics, when there is real-time sound processing.

<u>Experiment 2- Stereo Vs. Quadraphonic</u>

Feedback from Diogo Lopes

Excerpt 1:

- *With two speakers I focus more on the cello, everything comes from the front and the sound is more direct.*
- *With four speakers the electronics sound better, but I am less focused on the cellist. However, I am listening to everything, focused on everything - it is a better experience. It is more involved, makes a real difference.*

Excerpt 2:

- *The difference is huge. After listening with four speakers, two speakers is kinda horrible.*
- *In stereo, the natural sound of the cello was perceivable. The electronics were not so clear, it was not possible to have much difference between the waves and the rest.*
- *When the sound comes from the back, the cello's natural sound is possible to hear , but the general sound is much more rich and full. This is even more noticeable in this excerpt.*
- *For an optimal result, you should definitely use four speakers.*

Feedback from Jeroen den Herder

Excerpt 1:

- *With four speakers the sound is more full. Cello is more in the background.*

- *In stereo the balance was better, the quadraphonic definitely had more electronics. But I guess it depends on the musical moment.*

Excerpt 2:

- *Balance between the cello and electronics is probably a matter of taste.*
- *Using four speakers changes the perception completely*
- *It goes from being kind of centered on the cello and the front to be centered on the whole space*
- *It is nice to hear the sound coming from all around the space. I like the four speakers a lot, it is just a different concept.*
- *You should do a blind test, so that the eyes don't control my expectations*!

7.4.3 Third Research Cycle

Questionnaire 2- Marta Domingues (composer)

1. Could you briefly introduce yourself as a composer? What are your current research/creative interests?

Throughout my journey as a composer, I've focused on deepening the relationship between acousmatic music and instrumental music, exploring the reciprocity between gesture, sound, and space. My Master's project in Composition at Lisbon Music University was centered on concepts from acousmatic practice, such as archetype and space, extrapolating them into my acousmatic, instrumental, and mixed works. This line of research has been guiding my creative practice, leading me to question the boundaries between the fixity of electroacoustic music and the plasticity of performative gesture. As such, I've been exploring ways to incorporate gesture — as physical movement — and its expressive relationship within sound and musical creation. This exploratory approach has naturally led my compositional practice toward the search for a notation system that combines traditional language with graphic elements, aiming to translate the physicality of gesture and support musical interpretation.

2. Were there specific topics (like acousmatic music, spectralism, spatialization, etc.) that influenced your approach in this piece?

There is a concept from acousmatic composition that particularly shaped my thinking in this piece: the *séquence-jeu*. It refers to an improvisation with an object — any object — shaped through a series of precise and controlled gestures, always paired with attentive listening, with the intent of building an expressive musical phrase. It's an action that creates a familiarity with sound. The focused management of energy and how it unfolds in time also becomes a way of guiding listening and memory. This is an approach I'm interested in exploring in my works, and particularly in this piece for Baroque cello, where the different physical gestures of the performer allow the bow to extract the widest range of timbres, textures, and densities from the strings. In turn, the electronic space functions as an expressive medium that emphasizes and amplifies these gestures.

3. How would you describe your initial reaction to the timbre of gut strings? Why did you ultimately decide to write the piece for Baroque cello?

Unlike the metallic and resonant sound of the modern cello, gut strings on the Baroque cello have a more intimate and expressive sound, with a softer tone. Additionally, gut strings take a bit longer to "respond" to the bow's movement, demanding greater precision in each gesture from the performer. These factors lead to a more detailed consideration of each movement and the exact pressure the bow must apply to the strings, in order to fully explore the instrument's rich timbral and harmonic potential.

4. What characteristics stood out to you in using the wolf-tone eliminator? Why did you decide to integrate it into the piece's sound world?

The wolf-tone eliminator completely alters the familiar timbre of the cello. It gives it a more abrasive, almost screaming character — neither aligned with its Baroque identity nor resembling the modern cello. The way it interacts with different bow positions and with how the string is pressed or merely touched opens up a rich sound world, full of contrasts and unexpected textures.

5. How do you see the role of gesture-based improvisations in this process? Would you say they directly influenced your later writing?

Gesture-based improvisations were essential to the creative process, allowing a free and spontaneous exploration of sounds on the cello and in electronics — particularly important given the distinctive voice of the Baroque cello. Working in artistic residency allowed us to test expressive and technical approaches, leading to the discovery of surprising sonic gestures and interactions between the instrument and electronic effects. These improvisations provided a space to experiment with amplification, spatialization, and sound transformation — all of which directly influenced the final piece. Many ideas born in these sessions became part of the final composition — in textures, gestures, and the way interaction between cello and electronics unfolds. Improvisation played an active role in shaping the piece organically and reflectively, grounded in shared discoveries between performer and composer.

6. During the tests in September (on Reaper), do you remember which effects were used? What were you trying to explore with each one?

We mostly explored ring modulation, frequency modulation, and timbral alteration through various filters (low-pass, bypass, high-pass). The goal was to create moments where the cello's timbre would be completely transformed. However, the final results were not particularly exciting.

7. What criteria did you use to select or discard samples throughout the process?

The initial idea was to include pre-composed samples triggered throughout the piece, essentially using fixed media electronics. But we chose not to use samples and instead work only with simple effects like reverb, delay, and controlled amplification in space. This decision came from the desire to treat electronics as an *extension of the cello*, as if the instrument expanded into space.

8. Did any effects stand out to you as more expressive, spatial, or technically effective?

The relationship between space and reverb or delay is very strong — both acoustically and perceptually. Reverb allows us to create different virtual physical spaces. Delay simulates an echo, like what happens naturally in large or reflective environments. Both effects are ways to simulate, manipulate, or reinvent

space through sound. They affect how we perceive dimension, distance, location, and time — capable of creating atmospheres and layers of sonic meaning.

9. Did the idea of spatialization influence your compositional choices? How do you imagine space playing a role in how the piece is heard?

The piece plays with the amplification of the cello — sometimes on, sometimes off — teasing the idea of spatial expansion or displacement of the instrument, which is placed at the center of four loudspeakers. This forms the central idea behind using space as an expressive musical parameter in this piece: the electronics and diffusion displace and transform the cello's own sound, while also emphasizing the physical gesture of the performer who generates that sound.

10. In your view, can this piece be considered a form of chamber music? Why?

Chamber music involves close dialogue between performers. In a mixed piece like this, that dialogue happens between the acoustic instrument and the electronics. In this piece, the cellist exists in an active feedback loop with the electronically generated, processed, or spatialized sound — just like they would in musical dialogue with another musician.

11. What's the main reason you chose not to include a live electronic performer? Do you think this changes how gesture is perceived?

The fact that the cellist controls electronic parameters autonomously places them in a dual role: performer of the instrument and of the electronics. This makes the relationship with sound even more direct and personal — the performer acts and reacts to what they provoke in a very immediate feedback loop. To me, the main reason for not including a second performer is precisely this: to create a unified gestural relationship, where the cellist controls both the physical sound and its spatial/sonic transformations — merging both worlds into a single performative gesture. Gesture is extended into space through spatialization, which can even be literal: for instance, if the performer makes a circular bowing gesture, the sound spreads across the four speakers in a circular trajectory, with the performer controlling the speed of both circles (physical and virtual). In this way, gesture becomes a synthesis of sound, space, and performative intention.

<u>Quasi-Experiment Report: Cellist Positioning</u>

This quasi-experimental test followed the finalization of the electronic component of the piece. The aim was to verify whether the physical positioning of the cellist - inside versus outside the spatialization perimeter - has any perceptible effect on the musical and spatial perception of the work created thus far.

Test 1: First page (outside the spatialization field)

- **Material tested:** First gesture of the first page
- **Electronic behaviour:** Activation of amplification and spatialization through expression pedal; gesture intended to expand sound spatially in volume and direction.

Cellist feedback (Pedro):

> “I couldn’t hear anything.”

Composer feedback (Marta):

> “The electronics were present as before, but the idea of a gradual link expanding the gesture in this section, from the clean sound of the Baroque cello into space, was lost.”

Test 2: Second page (outside the spatialization field)

- **Material tested:** First section of second page
- **Electronic behaviour:** Activation of delay spatialized rotation through expression pedal

Cellist feedback (Pedro):

> “I could perceive movement, but it was impossible to perceive how it was situated in space. It felt almost like a large mass, without edges or a perceivable origin.”

Observations & Conclusions

Marta:

> “Everything changes if the cellist steps outside the space — the continuity of gesture is broken, also visually (the cellist stands out on stage, outside the quadriphonic field). The sonic relationship between cello and electronics is paradoxically worse. The cellist’s sound, now visually highlighted, is overlaid by four sound sources positioned closer to the audience.”

Pedro:

> “For the performer, being outside the electronic space — once you’ve been inside — becomes a far less exciting musical experience, even counter-natural. Instinctively, while playing outside, I was imagining interacting with the electronics as if I were inside the field, simulating how the electronics would sound from that perspective. A possible solution could be the use of an ‘electroacoustic performer,’ but there’s still an imbalance for the audience between the ‘clean’ sound of the cello — the origin of the gesture, whose timbral richness, particularly in a Baroque cello, also deserves to be experienced — and the four quadriphonic loudspeakers which are much closer to the audience. To mitigate these imbalances, both parties adopt technical compromises. But in the end, the final result that is heard is always the electronics, and the cellist cannot verify whether the sound they produce is being ‘delivered well’ or not. The cellist always has less musical agency under these circumstances, with a hierarchical imposition that weakens mixed music as a form of chamber music. Because in chamber music, even when hierarchies exist, all participants are aware and consenting of the final result.”

Marta (metaphor image):

> “It’s like composing a piece for solo cello (in which the cello part has a central musical role) accompanied by a trombone quartet. But the four trombones would be surrounding the audience, very close and prominent, while the cello would be further away. No one would do this. The balance issues would be irreducible, no matter how much the trombones try to play piano. Even if softened, all that effort would likely affect musical performance. It makes no sense to write a mixed music piece that claims to be chamber music, and that defends real-time spatialized electronics as an expressive resource (and thus an opportunity for interaction/reaction for the performer) if the performer cannot hear the electronics in their full richness.”

<u>Interview Report- Feedback Session with Prof. Carlos Caires</u>

Meeting conducted online on April 4th 2025, Marta and Prof. Caires present in-person at Escola Superior de Música de Lisboa. The conversation was not recorded; the quotations have been reconstructed immediately after the meeting. They are presented here in good faith and without interpretative alteration, but have not been reviewed by the interviewee.

1. On Interface Complexity and Performer Accessibility

> Carlos Caires: “That doesn’t really need to be taken into much account,” in reference to the accessibility of electronics use, “since this music is performed by specialized performers.”

2. On interface design

> “Nowadays it’s common to have a more complex pedalboard, or even to use sensors that can replicate the performer’s gestures,”
> “not just the two [interfaces] we selected (event trigger and MIDI expression pedal).”

3. On the Cellist’s Positioning and Lack of Precedents

> “Tradition is very strong,”
> *— this was Caires’ explanation for the absence of precedent in placing the performer inside the spatial field rather than using traditional staging,* “even in more experimental creative contexts.”

4. Regarding this project’s approach

> “It’s a great idea.”
> “There’s a need for pieces with this kind of approach.”

However, he emphasized:

> “It’s important to reinforce monitoring for the cellist.”

He offered technical guidance on how to mirror the Max patch on a monitoring iPad, and recommended adopting:

> “A more natural notation for the electronic part,”
> referring specifically to the graphic fader notation commonly used in electroacoustic performance scores.

5. On Spatialization and Technical Reinforcement

After reviewing the patch, Caires commented:

> “This aspect — the technical tuning of the spatialization distribution during manipulation — is of high importance given the nature of your piece.”

He suggested adding a testing section to the patch:

> “One that uses a pre-recorded sound to allow testing of different sections of the patch and facilitate balance adjustments between performance spaces.”

6. On Performer Autonomy and Patch Design

When asked whether a non-Max-experienced cellist should be able to operate the patch independently, Caires affirmed the principle of autonomy and clarified:

> “An accessible patch is one that is well explained — with text messages indicating every step, from connecting the microphone onward.”

7.5 Appendix 5: Transcriptions, (annotated) scores, analyses

7.5.1 Research Cycle 1 and 2

Près: Score & electronic materials

- Score of *Près*, for cello and electronics: ***link***
- Electronic materials of *Près* (Max patch): ***link***

Transcription of the composer's notes[87]
Près (1992)

Près for solo cello and electronics emerged at the same time as Amers, a concerto for cello and chamber orchestra. The musical material in the two works is to a large extent the same, but it is used in very different ways, and in terms of form and dramatic structure the pieces are strikingly different. The only identical elements are certain passages for the solo instrument and a few of the electronic materials. Both works were produced at IRCAM, and a few of the electronic component is very important in each case; in Pres the electronics continue and expand the musical gesture of the solo instrument in many different directions.
Prés is in three movements. The first movement concentrates on a rather linear texture in which the cello part is sometimes fused with the synthetic sounds. This material is based on recordings which | made with
Anssi Karttunen and have subsequently either analysed and used as the starting point for the work's harmony and sound synthesis, or transformed in various ways. The synthetic element is realised using resonant filters that also operate in real time in the later movements, where the cello sound is modified on a music workstation developed at IRCAM.
As a whole the electronic element consists of synthetic sounds, modified cello sounds stored in the computer, and real-time sound processing. This latter element has made use of resonating filters and different types of delay, space-filtering, and transposing techniques. The programming work was realised by Xavier Chabot and Jean-Baptiste Barriere at IRCAM.
The title of the work links to its sister-work (Amers, a nautical term for a leading marks or landmarks), and also to Paul Gaugin's painting By the Sea; and hence to the experience of the sea itself and waves, their different rhythms and sounds, stormy weather and calms. In other words: material, wave shapes, rhythmic
figures, timbres. The charging up of the music and the ultimate release of that charge.
Prés is dedicated to Anssi Karttunen, with whose collaboration I completed the piece, and who gave the first performance in Strasbourg on 11th November 1992.

Kaija Saariaho

Annotated Scores of _Près_

[87] Près," Kaija Saariaho, accessed May 27, 2023, https://saariaho.org/works/pres/

- Bow technique annotations: ***link***
- Performance Score- Set. 24: ***link***

Analyses

Full Text Analysis of *Près* (for cello and live electronics):

The composition *Près* by Kaija Saariaho is a work for cello and live electronics that explores the interplay between timbre and harmony, as well as the integration of acoustic and electronic elements. The piece was developed based on another composition by Saariaho named *Amers*., for solo cello and ensemble. While both works share a similar underlying musical idea and basic sonic material in the solo cello part, they differ significantly in terms of form, structure, sound space, and overall atmosphere.

In the creation of the electronic part of *Près*, the sound originally came from sampled sounds of some experiments that the composer conducted with Anssi Katturnen. His cello was equipped with a special microphone developed for the piece, which consisted of four pickups that isolated the audio signals of the four strings from each other. This unique setup allowed a single bow stroke to become a spatial gesture. The electronics of the first section of the piece are based on the digital spectral analysis of the first note, an E flat with an harmonic trill. The trill alternates between normal sound and natural harmonic sound, progressing from playing "sul tasto" to "sul ponticello." From these analyses, two spectra are derived: a complete spectrum with all components and a reduced spectrum that retains only perceptually relevant components after frequency masking. Synthesizing the complete spectrum produces unique timbres, while synthesizing the reduced spectrum generates a set of pitches perceived as harmony. This analysis of the trill serves as a central element in defining the movement between harmonic relaxation and tension and establishing coherence between the instrumental and synthetic sounds in the piece.

In addition to the exploration of timbre and harmony, *Près* incorporates various transformation processes that run concurrently with this duality. The cello part undergoes a lot of transformations in playing techniques , such as transitions between contact points, trills, tremolos, glissandos, use of microtones, harmonics, and the transformation of sound into noise through the overpressure technique. These transformations are mirrored in the electronic part. Rhythmic processes and the interplay between static and dynamic elements further contribute to the sonic evolution. The cello part's pseudo-regular and repetitive patterns spread across the four strings and overlap with the different extended techniques and sound transformations. The electronic part, based on the sampled cello experiments mentioned above, can interpolate between sounds with varying levels of harmonics. It is controlled by independent processes for rhythm and timbre variation, resulting in a dense polyrhythmic texture when combined with the live cello performance. The contrast between pure and noisy elements is introduced abruptly in the cello part and amplified in the electronics through the playback of a cluster sound and the activation of a real-time time-stretching module.

The use of real-time computer processing in "Près" allows for the creation of various textures starting from cello sounds, evolving between noisy and crystalline characteristics, reminiscent of the violence and tranquility of the sea. The title *Près*, which means "close" or "near" in French, refers not only to its association with the twin piece *Amers* but also alludes to the concept of proximity to the ocean. It draws

inspiration from the works of Saint-John Perse, particularly his work *Amers*, which explores the experiences that enable individuals to transcend conventional boundaries. In *Près*, the cello functions as a navigator, directing itself amidst the waves created by other instruments and synthesized sounds. The composition delves into the thoughts and reactions of the navigator as they gaze upon the sea, embodying the diversity and unity inherent in being.

Full Analysis of the Max-patch (all references from downloaded version)

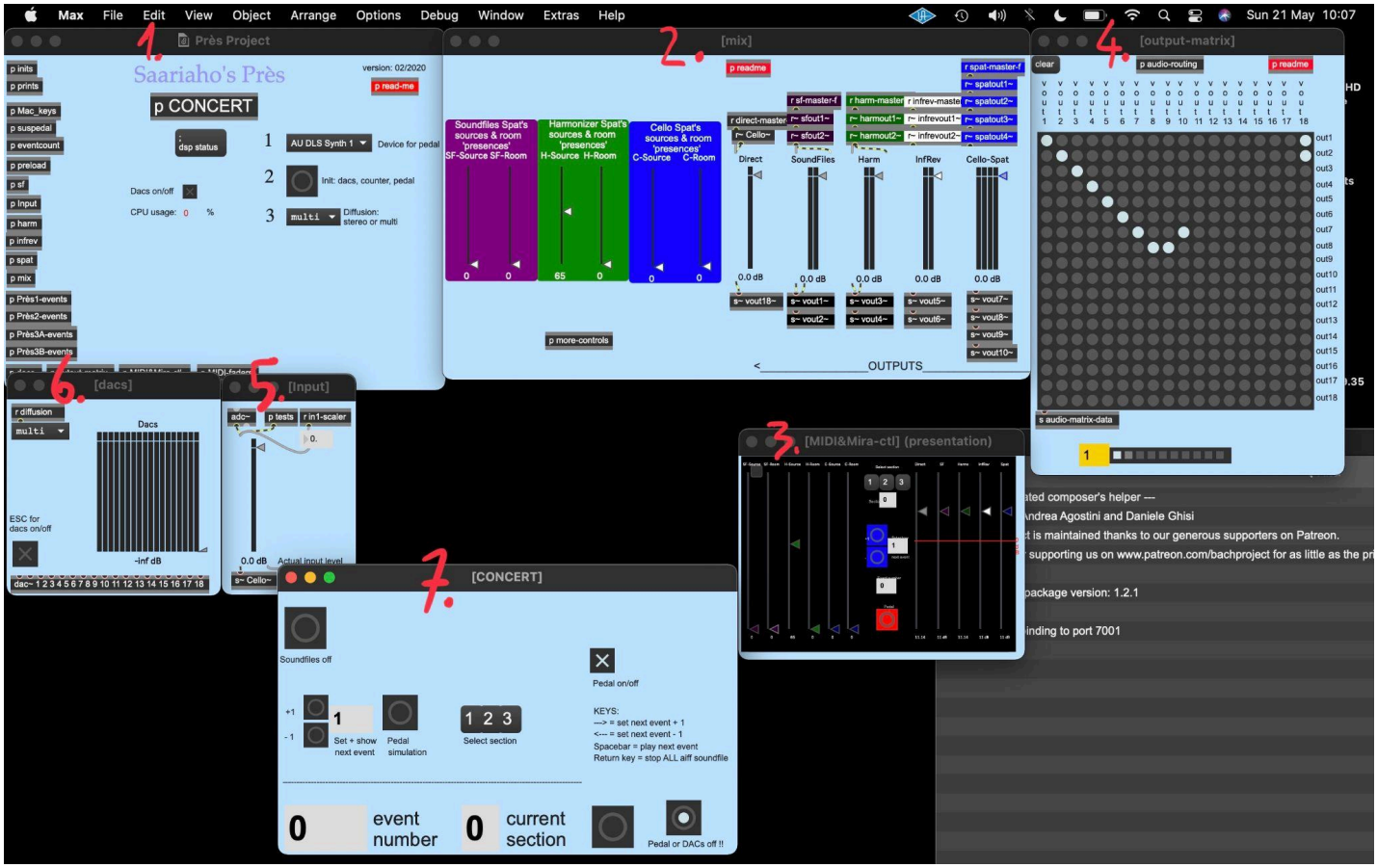
General information

"The electronics for this piece can be run with a Max patch that includes infinite reverberation, general reverberation, harmonizers, and plays pre-recorded sound files. Cues in the score must be triggered by the performer with a sustain pedal (or by another musician directly on the computer at the mixing desk).
In both rehearsal and performance the sound engineer/musician should read the score and adjust the relative levels of the cello and electronics on the mixing desk, according to the given context (musical interpretation, equipment, acoustics of the performance space).

Downloads: latest version (including sound files). Does require Max installation."

Patch Analysis
The Max patch was developed and is constantly updated by the composer and sound engineer Jean Baptiste Barrière. The composer was a resident technician at IRCAM in 1992, closely following the compositional process of this piece with composer Kaija Saariaho and was responsible for the original technical realization of the electronic part of this piece.

Upon opening the downloaded file in the Max-MSP application (version 8), the 7 user- interactive windows of the patch appear, each addressing various important technical issues (screenshot below).



1- *Près Project* (main window):
It is basically a main menu that contains the on/off buttons for the entire system, as well as the on/off button for the overall audio output.
However, its main function is to list (on the right side) all the shortcuts that lead to the sub-patches of the piece, which contain all the "raw" programming of the patch. These sub-patches are not visible (also not user friendly), and it is through this main window that it is possible to access them, which is important in case there is any technical incompatibility and a small adjustment in the programming needs to be made.

2- Mix:
The digital mixing console of the entire patch, where it is possible to control various parameters of the patch. It is also possible to route the faders to a MIDI controller and have a physical possibility of controlling them.
Firstly, it is important to identify all the sound parameters of the general patch.
In terms of sound effects, the patch contains a constant reverb, a succession of events - triggered by a footswitch, and a harmonizer (only used in the third movement). Each of these effects has a personalized intensity fader that controls the levels of sound transformation (on the left side of the Mix window, in colors).
In addition to this, there is direct amplification of the cello, which can also be controlled in a set of volume faders, now on the right side of the same window. On that side of the window is a section

that is essentially a basic mixing console, only controlling the overall volumes of all the mentioned parameters. According to Barrière, this is the only section that needs adjustment according to the acoustics of each performing room.

3- *MIDI&Mira controls:* (optional)
A short-cut mirror controller for when plugin in a midi device for physically controlling the faders of the mixer.

4- *Output Matrix:*
This section allows the user to map the number of outputs of the patch, depending on the number of speakers of each concert hall or rehearsal space.
The basic performance setup, according to Barrière, is made for four speakers (two in the front and two in the back), with the ideal performance being between 8 and 18 loudspeakers. It is also possible to map a stereo version for individual practice.
The high number of speakers for the ideal performance (between 8 and 18) is because the entire patch is spatialized. In other words, the different parameters mentioned earlier are distributed across the different speakers throughout the piece, creating a fully immersive atmosphere for the listener.
The distribution of parameters in space changes according to various factors such as intensity of the cellist, dynamics, sound spectrum, type of activated event, etc., conveying an actively rich acoustic sensation, almost like a living organism that reacts in real-time to the cellist and the space.
These acoustic possibilities of the relationship between timbre and space are Saariaho's main focus of study at this time, and for me they represent the ultimate artistic possibilities of real-time electronics in this piece.

5- *Input*:
Where it is possible to control the analogic volume level of the cello microphone.

6- *Dacs:*
In Max/MSP, "DAC" stands for "Digital-to-Analog Converter." A DAC is a device or module responsible for converting digital audio signals (represented by binary data) into analog signals, which can be understood and reproduced as sound by speakers or other analog audio devices. In this case, it handles the conversion of the digital signals of the processed sound into analogue signals that go to the selected number of outputs (or loudspeakers).

7- *CONCERT:*
In this window, the connection to the cellist's pedal is verified, allowing for monitoring of the remotely activated event. It is also here, in rehearsal situations, where the electronic pickups are defined if it is intended to rehearse a specific section with electronics, without having to go through the entire sequence of events to reach the desired spot.
It is also in this window where the launch of events is monitored when they are triggered by someone at the computer (it is always possible to launch them by pressing the spacebar).

Transcription of Patch Information Text (*Readme's*)

Main Window (*Près Project)*

"The Diffusion switch (in the main window) allows to change globally the routing of all audio outputs between stereo and multichannel diffusion, whatever the way one wants to dispatch the outputs channels in the Output-matrix window. However, it is assumed that the concert set up will be using 'multi' rather than 'stereo', which is to be used mostly for tests (and/or when working without sound interface).

The patch is meant for quadra. However, we provide the possibility to route the different elements of the patch to different outputs, so that they can be ideally mixed separately, or to allow any ad hoc combination depending on a particular sound set up.

Ideally, the virtual outputs should get out to different hardware outputs (hence Preset 2 in the Output-matrix window). This is why we provide a general output-matrix which can accommodate up to 18 outputs channels (useful for instance with common interfaces with 8 analog, 8 ADAT & 2 Spdif outputs, which can be then connected to some compatible digital mixers; or possibly with Ethernet through Dante protocol, cf: http://audinate.com).

But most people have interfaces with only 8 outputs, so the default preset (Preset 1 in the Output-matrix window) is therefore made for an 8 outputs channels configuration, and is ready to typically achieve quadra by mapping the 8 outputs to 2 superimposed quadras:
- outputs 1, 2: Front
- outputs 3, 4: Rear
- outputs 5, 6: Front
- outputs 7, 8: Rear

However, outputs can be organized differently, to suit a particular set up, for instance if using more than 4 loudspeakers.

There is a control layer with Mira (or any MIDI fader box one can use to control Max). This allows to have some virtual channels premixed in the output matrix, and still have the possibility to mix them separately through Mira or MIDI.
If you have access to an Ipad or to a MIDI fader box like the BCF2000, we recommend using these capabilities.
One can also control events through OSC by sending with the udpsend object 'bangs' to port 7001 (see suspedal window)."

Mixer

"The cello, the sound files and the harmonizers have each one their own Spat (reverberation/spatlizalizer).

The Spat allows to control separately the 'Source presence' and the 'Room presence' (on a scale 0-120).
The Source is the original signal but spatialized, moved in Azimuth and Distance automatically, in stereo or quadra depending of the case.
When relevant, an other level of control is available: the 'direct' signal and the 'spat' (the signal passing through the Spat) are controllable separately (on a scale 0.-1.).
Note that the original signal is present both in the 'direct' signal, and in the Source of the relevant Spat; but in the second case, it is also spatialized. These two levels of controls allow many combinations, which can be useful in different musical contexts.

In theory, the basic initial levels set in the patch should not need to be greatly modified, except to adapt to a given interpretation and to the acoustics of a given concert hall.
However, in practice, it is always necessary to adapt the final mix, which implies that ideally somebody with musical reading capabilities should always be at the mixing desk, following the score, and adapting the mix according to the musical needs.
As a basic principle, the instrumental sound should never be covered by the electronics. The ideal mix is one that blends them completely.

If needed, the balance between direct and reverberated/spatialized sound, can be achieved through the other controls provided: direct vs spat, and/or source vs room presences.

The final mixing of the outputs can be done by controlling the outputs levels on an external mixing desk, or alternatively with the Mira interface provided.
Note that changes in the Mira window are mirrored in the mix window, but changes in the mix window are not mirrored in the Mira window."

Output-Matrix

"Remap here the 'virtual outputs' (vout1, etc.) of the Mix window,
according to a specific set up (sound interface, mixer, number of speakers, etc.).

The patch is conceived for a quadrophonic diffusion around the audience, so that:
- soundfiles (vout1&2): should be in the front
- harmonizers (vout3&4): should be in the back
- infinite reverb on the flute (vout5-6) should be in the back
- Spat (instrument reverberation and spatialization, vout7-10) should be all around the audience

Preset 1, conceived for the most current (as observed from experience) set up: a sound interface with 8 outputs. Therefore vouts 9-10 are remapped to outs 7-8, to comply with this constraint.

Preset 2, allow up for 18 outputs (for instance if using Dante's protocol).

If you only have a stereo system, you can just remap the rear outputs to the front. Note that the selecting 'stereo' in the main window does that without needing to change the output matrix.

A direct output of the cello (if not available through a mixing desk) is provided on vout18.
However, note that controlling Cello's Spat Source does basically the same thing - control the

direct sound - but spatialized, that is moving around the 4 theoretical outputs of the given Spat; while vout18 can be remapped wherever needed with the matrix.”