The Larsen Station: A Customizable Module Setup for Integrating Electroacoustic Feedback in Chamber Music

Maurilio Cacciatore
mauriliocacciatore@steffani.it
Conservatorio "A. Steffani"
Castelfranco Veneto, Italy

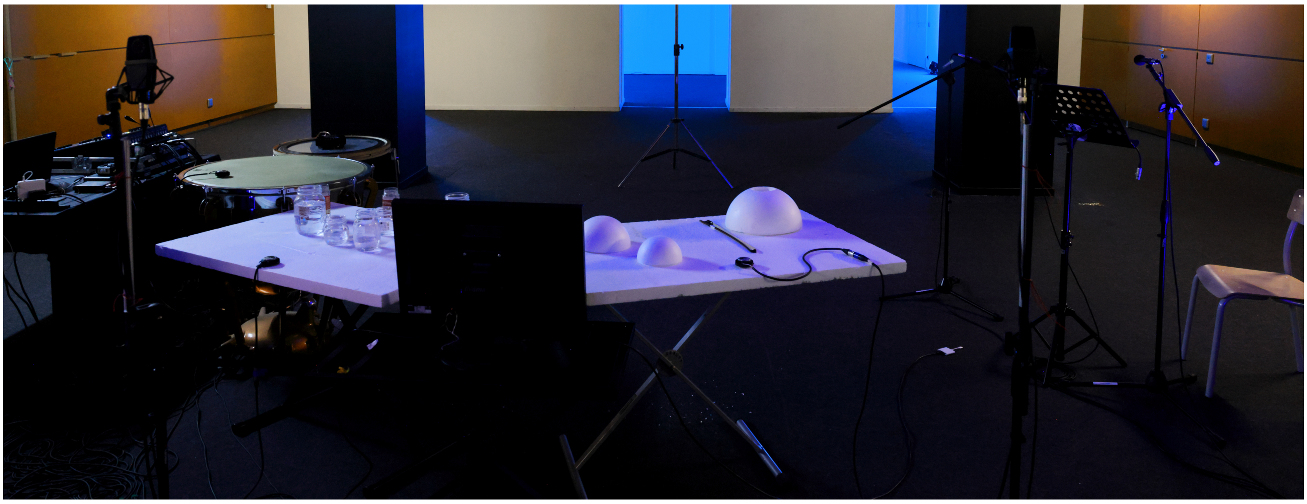

Figure 1: The Larsen Station used in *Touching the air* (2025). ©HANATSUmiroir. Photo by Pauline Marfaing

Abstract

Touching the air (2025) is a work for Larsen Station, flutes and live electronics, commissioned by Ensemble HANATSUmiroir. This paper presents the Larsen Station, a modular setup developed for the piece, and situates it within an ongoing research on the control and compositional use of electroacoustic feedback in chamber music.

Developing from the Larsen Glassharmonica (2024), the setup overcomes the structural and sonic limitations of earlier piano-based configuration by decoupling feedback generation from large acoustic infrastructures and increasing configurational flexibility. The Larsen Station comprises multiple resonant modules: polystyrene boards, glass Helmholtz resonators, a kettle drum, and a low-frequency bass-drum unit, excited by contact loudspeakers and shakers. The paper discusses material choices, excitation and capture techniques, live electronic processing, and notation strategies, emphasizing gesture-based interaction in which hand movement and spatial positioning directly shape pitch, timbre, and stability of electroacoustic feedback.

Keywords

Electroacoustic feedback; Larsen Glassharmonica; Polystirene; Feedback-based instruments;

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1 Introduction

Touching the air (2025) [7] [8] is a work for Larsen Station, flutes (Piccolo, C Flute, Alto and Bass Flute), and live electronics, commissioned by the Ensemble HANATSUmiroir [13] and premiered in Strasbourg on May 23, 2025. This paper introduces the Larsen Station, a musical setup developed for this project, and situates it within my ongoing research on the control and compositional use of electroacoustic feedback in chamber music.

The Larsen Station develops from the Larsen Glassharmonica [5], an instrument designed to tune electroacoustic feedback using glass jars as Helmholtz resonators mounted on the frame of a grand piano. In that configuration, feedback was excited through vibrations transmitted to the piano soundboard via contact loudspeakers, enabling stable pitch formation and performable control.

Although effective in formalizing feedback tuning, this setup also brought to light several design constraints, including dependence on a grand piano, limited modularity, and restricted flexibility of the stabilized feedback signal. The present work addresses these aspects by proposing a system that can be reliably reproduced and reconfigured by other musicians, without requiring the transfer of physical prototypes or the author's direct involvement. Other feedback-based instruments such as the Mop Cello [19], the Magnetic Resonator Piano (MRP) [14], and related works provide highly refined and musically rich solutions, though their construction-specific approaches can make replication and scaling across multiple units less straightforward within certain compositional contexts.

Similarly, systems based on 3D-printed components, custom-built surfaces, or dedicated electronics, such as the Self Resonating Feedback Cello [10], the Feedback Resonating Double Bass [12],

and the Feedback Trombone (FBT) [17] highlight important design directions, while also pointing to the relevance of exploring alternative strategies for broader accessibility and dissemination. The ergonomics of the performers was also considered, particularly with respect to the use of cables between the instrument and the DSP station, which can affect mobility and comfort in performance situations, as observed in setups such as the Feedback Bass Clarinet [15].
These considerations informed the design of the Larsen Station, which seeks to decouple the instrument from large acoustic infrastructures, enhance configurational flexibility, and offer a more adaptable feedback signal for live electronic processing.

2 Hardware setup

The Larsen Station is made up of four modules. The first two modules feature polystyrene boards (100 × 70 × 4 cm) as a surface on which various objects can be placed and repositioned to generate and tune the electroacoustic feedback. A 29′′ kettle drum serves as the third resonant body, while the fourth module consists of a frame with a small synthetic bass drum membrane placed horizontally. Polystyrene boards are the most commonly used surfaces in this composition, and their material properties are critical for achieving the desired sound. For this project, the optimal boards have a density of 15 kg/m^3, which is the European standard for isolation panels [1].
Electroacoustic feedback in the first three modules is excited using Dayton Audio DAEX32EP-4 contact loudspeakers (40 W), while low-frequency feedback in the fourth module is generated using a Dayton Audio BST-1 bass shaker. The use of Schertler ACC-PUT-1 putty has been used to fix the small loudspeakers to the surfaces and also improves the behavior of the exciters.
Both polystyrene boards allow the contact loudspeakers to vibrate properly and are capable of diffusing sound with sufficient loudness for a chamber-music context, without the need for additional digital audio sources. It is essential that these boards be placed on X-style keyboard stands, with no supporting surface underneath. Any additional contact surface would impede the transmission of vibrations within the polystyrene; moreover, the resulting increase in rigidity could cause excessive mechanical stress on the loudspeaker.
Specialized frequency compensation is required prior to sound output. A Max package based on Gen~was developed in 2021 [11] during a research residency I conducted with the Syntax Ensemble, supported by the Festival Milano Musica.
The sound capture is made through a DPA-4060 omnidirectional microphone. The use of such a transducer allows for the exploration of surfaces and good handling while performing. The use of a radio system like the Sennheiser XSW 1 ME2 significantly improved performance, thanks to its limited frequency range and the internal DSP of the wireless system. By sending the signal from the radio transmitter at an amplitude of -30 dB and applying software brickwall compression, the resulting acoustic feedback achieves a loudness comparable to that of a chamber music instrument. The setup of the device to capture and diffuse sound follows the schema in Figure 2.
Another important reason for using miniaturized microphones is the ease of handling they provide. When the performer is within approximately 1 m of the boards, enclosing the capsule in the hand allows the electroacoustic feedback to be modulated directly by the position of the hand. The resulting feedback varies according to both the distance from the loudspeakers on Boards 1 and 2 and the spatial orientation of the hand. This physical, gesture-based interaction gives meaning to the title of the work: the performer must develop a heightened sensitivity to movement in the air. When the score calls for exploring different pitches, the performer navigates the space above the setup, varying hand position with respect to each board to select the desired fundamental. Conversely, when the score indicates that a specific pitch should be sustained, the performer must maintain a stable hand position to prevent unintended pitch fluctuations. Audio feedback control is inspired by D. Sanfilippo and A. Valle feedback systems [16] as well as A. Di Scipio's LAR mechanism and its subsequent variations [9]. Max is used for the processing of electroacoustic feedback and for the other components of the live electronics. Logic Pro X is used exclusively to provide the click track for musicians and to trigger changes of state within the Max patch.

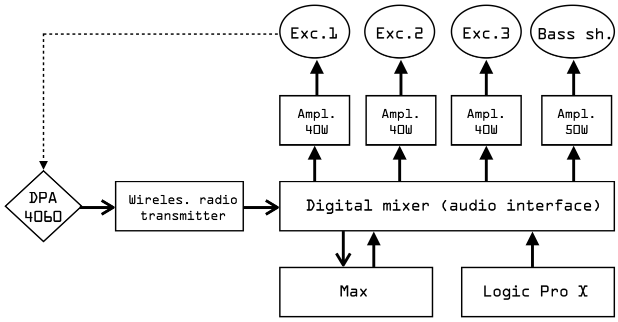

Figure 2: Hardware connections used in *Touching the air.*

2.1 Polystyrene board 1

This board is equipped with three polystyrene half-spheres of different diameters, as shown in Figure 3. Electroacoustic feedback can easily be triggered by placing the microphone capsule against an edge. The shape of the half-spheres allows the performer to vary the pitch of the feedback. The resulting pitch depends on the distance of the half-sphere from the contact loudspeaker, the position of the microphone capsule in space, and the shape of the performer's hand holding the microphone. When performing on this board, the musician is not required to produce specific pitches; instead, they follow the gestures indicated in the score, which yield reproducible and consistent sound outcomes.
Half spheres must be fixed with double-sided tape. The largest half-sphere can be modified by introducing an aperture of approximately 7 cm in diameter, allowing the DPA microphone to be positioned inside the cavity. This configuration generates high-intensity electroacoustic feedback, capable of reaching the peak levels defined by the brickwall compressor. Sustained placement of the microphone in this position produces vibrations of sufficient amplitude to displace the entire board, highlighting the strong mechanical coupling between the resonant structure and the feedback system.

2.2 Polystyrene board 2

The second board is a variation of my Larsen Glassharmonica, as illustrated in Figure 4. It uses a series of glass jars filled with different amounts of water, which act as Helmholtz resonators. In other words, the jars enable the triggering of pitched electroacoustic feedback.

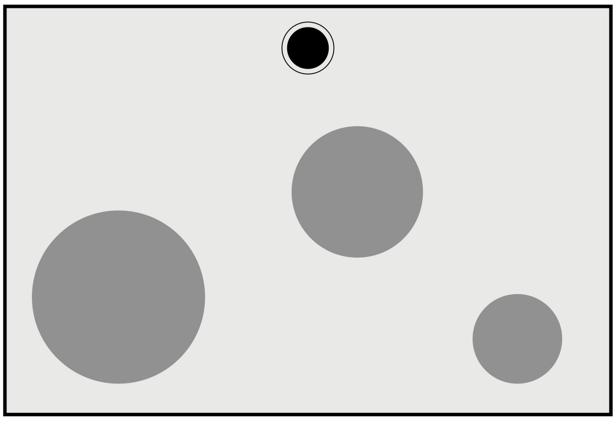

Figure 3: Board 1. Three half spheres for various electroacoustic feedback triggering. The black circle represents the contact loudspeaker

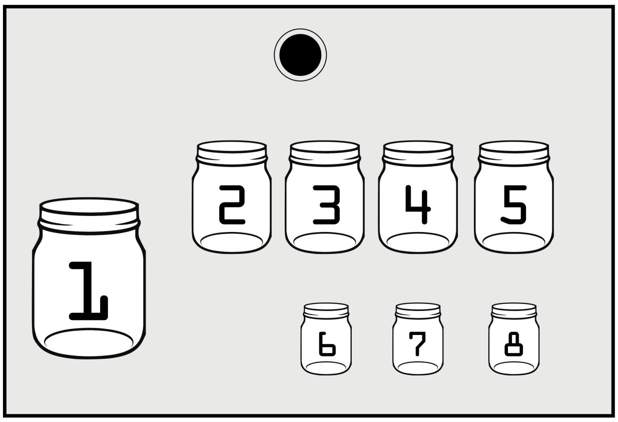

Figure 4: Board 2. Larsen glassharmonica made with eight glass jars

Bormioli jars [2] are well-suited for this application due to their regular shape and wide entry opening. For this research, Bormioli glass jars were chosen due to the widespread international presence of the company and the familiarity of its products in both commercial and design contexts. Their standardized and reproducible shapes, consistent proportions, and wide availability make them suitable for controlled experiments and to ensure the comparability of the results in different settings.

Each jar can produce one, two, or three distinct pitches depending on its size and the depth to which the microphone capsule is inserted. Figure 5 shows the range of pitches available with jars of 25, 50, and 100 cl.

A pronounced wah-wah effect can be achieved by covering the hole of a jar with the palm while holding the DPA capsule inside, with the cable positioned between the ring and the middle fingers. This technique is effective in all sizes of jars. The speed of the spectral modulation produced, corresponding to the speed of opening and closing the jar hole, is inversely proportional to the jar's size, allowing performers to control the character of the effect through both hand motion and choice of resonator.

From a performer's perspective, this board provides a reduced sense of resistance compared to the Polystyrene Board 1. While the use of half-spheres requires a continuous negotiation to balance resonance and resistance [18], the integration of jars, together with the associated hardware and software, positions the Polystyrene Board 2 closer to a new instrument prototype. In this configuration, the production of pitched sound becomes more deterministic and can be articulated through a set of classifiable playing techniques.

Figure 5: complete pitch chart

Taking into account the dimensions of the board and the minimum safe distance of approximately 24 cm between the contact loudspeaker and the jars, necessary to prevent the generation of uncontrollable electroacoustic feedback, a series of eight jars was selected to produce the sound sequence illustrated in Figure 6. The lowest pitch in the series is achieved using an empty jar with a volume of 200 cl, ensuring both reproducibility and precise control over the resulting feedback. Filling water in these jars allows to trigger sounds with pitches similar to those available with a 100 cl jar.

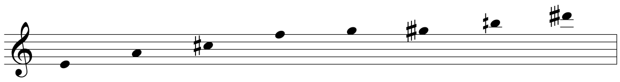

Figure 6: Tuning of jars placed on Board 2

2.3 Boards 3 and 4

Triggering electroacoustic feedback using a large kettle drum as the resonant body allows the generation of a complex timbre that depends on the instrument's size, shape, and material. Natural drum skins produce more pronounced and responsive feedback than synthetic skins.

The pedal can be used to modify the intonation of the triggered feedback, providing further control over the resulting sound. A clear pitch is audible only when the kettle drum pedal is at its highest tension. The richness of the spectral content is inversely proportional to the tension of the drum skin: although releasing the pedal allows for more complex sounds, it becomes difficult to perceive a distinct pitch. The range between the extreme pedal positions corresponds approximately to a perfect fifth, matching the pitch range the kettle drum would produce when played

conventionally.
A small bass drum was used to house the bass shaker. It generates a low-frequency drone with a fixed pitch and a limited amplitude range. Nevertheless, it plays an important role in the overall setup, helping to extend the electroacoustic feedback register to lower frequencies. The generation and control of low-pitch electroacoustic feedback remains challenging and has not yet been explored in depth. Figure 7 illustrates Boards 3 and 4.

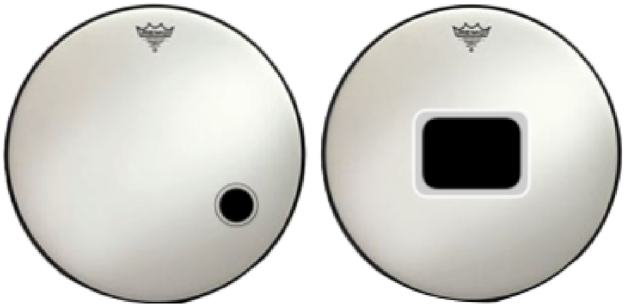

Figure 7: Boards 3 and 4: Kettle drum and Bass drum

3 Digital treatment of signal and software

All signal processing and control are implemented within a Max patch. The graphical user interface is built using *MMixte*, an author's modular package developed for designing customizable concert environments within Max [4] [6]. *MMixte* enables the real-time configuration and monitoring of signal routing, processing parameters, and diffusion strategies during performance. Figure 8 shows the patch in presentation mode.

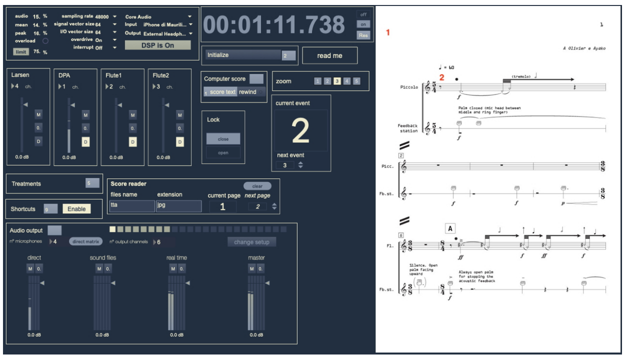

Figure 8: The Patch of *Touching the air* in presentation mode

Beyond the resonant surfaces of the Larsen Station, sound diffusion is realized through a 2.1 loudspeaker setup. Arturia EfX Fragments [3], a granular synthesis based plugin, is applied to both Board 1 and flute signals and diffused into the polystyrene boards and the stereo diffusion setup. In performance, the player shapes the feedback spectrum by physically moving the microphone across the surface of the board, selecting specific excitation points that determine the fundamental pitch of the electroacoustic feedback. Granular processing thickens the resulting sound and expands its spectral content, compensating for the inherently narrow square-wave-like timbre of the raw feedback signal.
A step sequencer is implemented as a sequence of 16 pitch-shift values organized into scales derived from the flute parts and from pre-recorded sound files. While the performer is responsible for initiating and stabilizing a specific feedback pitch through precise microphone placement, the sequencer operates on this continuously generated signal to articulate a melodic trajectory. In this interaction model, electroacoustic feedback functions as a dynamically controlled tonal reference, while signal processing translates performative gestures into structured harmonic and melodic outcomes.
The kettle drum and bass drum signals are processed with a spectral delay and a harmonizer with multiple intervals, enhancing the low-register sound to make it thicker and more harmonically complex.

4 Notation

The notation for the Larsen Station, as illustrated in Figure 10, balances the performer's freedom with precise compositional control. While the player interacts freely with polystyrene boards and other surfaces, the piece remains a fully deterministic chamber work, with all movements explicitly prescribed. Glass jars are notated using a tablature system rather than pitch, as shown in Figure 9, thereby enabling rapid identification.

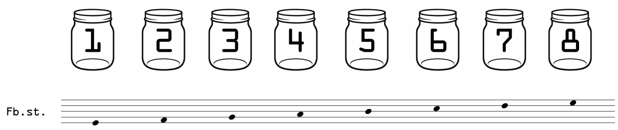

Figure 9: Tablature of the glass jars on the Board 2.

Miniature symbols for Board 1, the kettle drum, and bass drum replace conventional noteheads, while arrows indicate the direction or object to place against the microphone, integrating gestural, temporal, and dynamic information. A line below the first Larsen Station staff, marked with ♯ and ♭ at top and bottom, provides intuitive guidance for kettle drum pedal adjustments. This notation enables precise control of the microphone for sound production: in intimate electroacoustic feedback, it functions not merely as a transducer but as an active, responsive instrument shaped by the performer's chironomic gestures.

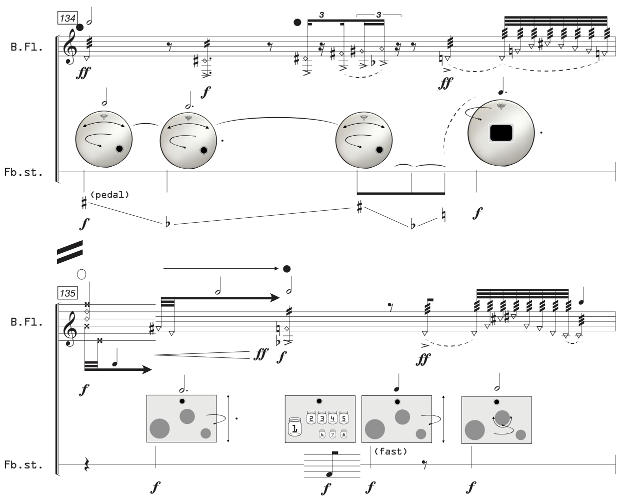

Figure 10: Score excerpt, p.39.

5 Further developments

Polyphony is the main enhancement planned for future versions of the Larsen Station. An approach is to implement two independent electroacoustic feedback setups, allowing the performer to generate multiple simultaneous sonic lines. In initial experiments with two DPA microphones, one placed on each polystyrene board, the omnidirectional capsules captured nearly identical signals, preventing perceptible differentiation. A redesigned board, built from a material optimized to enhance the acoustic properties of polystyrene and integrated transducers, would improve line separation, reduce setup time, and expand the instrument's performative potential.

6 Ethical Standards

This project follows ethical standards for artistic research: the performers gave their informed consent to documentation and recordings, all equipment is handled safely, and third-party software is used according to the licensing terms. The methods are described in transparent terms to support reproducibility.

Acknowledgments

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