Out-of-Control Feedback Systems and Collaborative Influence with the Instrumentalist Mixer Feedback Transmutation System

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Abstract

This paper explores the Instrumentalist Mixer Feedback Transmutation (IMFT) system, a modification of the typical no-input mixer paradigm meant for collaborative improvisatory performance (formally called NIMB+)[9]. IMFT occurs when an instrumentalist is patched into a mixing board with feedback loops (a.k.a no-input mixer). The instrumentalist interacts and influences the mixer's feedback together with another performer operating the mixer. Introducing an instrument into the no-input mixer's previously closed system creates possibilities for new collaborative interactions between humans and chaotic feedback systems. In this system, a chaotic, out-of-control relationship can be formed where the output of the mixer and the gestures from the mixer performer can be in battle with the input from the instrumentalist and vice-versa.

After a brief historical contextualization of mixer feedback, the IMFT system and the complex relationships that form between human and machine are introduced. No-input mixer performance practices are discussed, followed by exploration of a single feedback loop to illustrate some of the mixer's possible sound worlds and the nature of the instrument. Performance experiences from two recent compositions by the first author, *generative open graphic score #1* (2023) and *noise ritual* (2023), are described in order to explore different performance interactions created by different instrumentalists working with the IMFT system. This practice-based research provides a useful case study examining the entangled relationship between performers and interfaces in feedback-based music systems and how innovative approaches to an established electronic practice can create new perspectives and collaborative opportunities.

Keywords

New Interfaces for Musical Expression, Augmented instruments, Feedback, No-input Mixer

1 Introduction

The Instrumentalist Mixer Feedback Transmutation (IMFT) system—formerly referred to as the NIMB+—is a chaotic electroacoustic system designed to facilitate interaction and collaboration between performers and mixer feedback (a.k.a no-input mixer) [9]. The first author has composed for the IMFT and performed with it in improvisatory, collaborative contexts. IMFT expands the no-input mixer paradigm by connecting an instrumentalist's microphone input into a mixer along with feedback loops that is operated by a mixer performer. In this configuration, the instrumentalist engages directly with the feedback signal, manipulating it in real time with the immediacy and tactility typically associated with no-input mixing [13]. The mixer feedback distorts the instrumental input in turn, acting as a type of signal processing that manipulates the amplified instrument output. Although previous work describes the input of external controllers (e.g. sequencers) with no-input set ups [13], the use of acoustic instruments, patched in via microphone, opens up the possibility for more humanistic and virtuosic interaction with mixer feedback. The potential for performers to directly manipulate the feedback patch enables dynamic interactions with both the mixer performer and the self-sustaining feedback loop, creating new musical avenues for improvisation in live performance.

This paper explores the creative and technical potentials of the IMFT system with acoustic instruments. The research is exploratory in nature, guided by two central questions:

(1) How does IMFT extend the no-input mixer paradigm?
(2) What novel timbres or sonic behaviors can emerge from this configuration?

Drawing on performance experiences with various musicians across different settings, this paper positions the IMFT as an accessible, performative interactive feedback system and audio processing tool that foregrounds unpredictability and engages with noise-based musical practices. Previous work [9] introduced the IMFT and contextualized it within no-input mixer performance. Here, we build on that foundation by investigating how IMFT functions in live performance and how different collaborators shape its sonic outcomes.

The no-input mixer is a unique electronic instrument that has experienced a resurgence in the 21st century [2, 12, 13]. The term no-input mixer refers to a technique in which a mixer's outputs are fed back into its inputs, generating feedback loops. This practice was initially explored in the late 1960s by artists such as David Tudor and Pauline Oliveros [12]. Over time, this unconventional use of audio technology has been described as "creative abuse" [1, 5] and "hardware hacking" [6], among other terms. It has been widely adopted in experimental music genres, particularly noise music. The fundamental technique behind no-input mixer involves amplifying latent noise in the mixer to create feedback loops that can be manipulated using the mixer's faders, buttons, and dials. Controlling mixer feedback—and its behavior—is generally perceived as chaotic and unpredictable, particularly as the number of feedback loops increases. The unpredictability of working with mixer feedback has recently been linked to "entangled notions of agency" [13] within human-computer interaction emphasizing the complex interplay between human performers and self-sustaining electronic systems.

Typically, no-input mixer performers play similar roles to other instrumentalists in an improvisatory collaborative setting. They complement or contrast with other musicians, reacting in real time to the evolving sonic environment. In contrast to traditional no-input mixer performance, the IMFT system fosters

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a more collaborative environment in which the instrumentalist and mixer performer work together to shape the feedback of a shared mixer. The resulting sound can synthesize the mixer feedback and the acoustic instrument into a unified timbral entity, blurring the boundary between electronic and acoustic sources. In typical improvisatory settings involving no-input mixer and an instrumentalist, each performer maintains a separate and distinct sonic identity. Here, while the mixer still acts as an instrument, it is more so an effects processor and interactive collaborative system.

Inclusion of the instrumentalist opens the mixer's previously closed feedback system to external input, fostering greater adaptivity and human-machine interaction [19]. This enables the instrumentalist to interact with the feedback and generate sonic results that are not possible with the mixer alone. The self-sustaining feedback loops, shaped by the mixer performer, invite the instrumentalist to engage with the emergent musical gestures. Mudd [12] notes that a core characteristic of the entangled relationship that forms when performing on a no-input mixer is "co-creativity". Co-creativity occurs when human actions influence the system and the system's responses shape human decisions. In the IMFT system, this co-creative relationship extends not only to the mixer performer, but—more significantly—to the instrumentalist. Because both performers affect the feedback circuit, the entanglement with the system is heightened, producing a unique collaborative outcome.

1.1 Comparison to other Feedback Systems and Existing Work

This entangled interactivity contrasts with other unpredictable analog feedback systems such as the one used by David Tudor in his realization of John Cage's *Variations II* [17]. While Tudor's system similarly embraces unpredictability, it does not act as an autonomous instrument: it only produces sound when triggered by his external input. Moreover, it lacks the timbral possibilities of mixer feedback, and thus encourages interaction in a different, more limited, manner. Elia and Overholt's "digitally controlled analog no-input mixer" introduces digital controls as an "extra layer of mediation" between performer and feedback [8]. Similarly, in the IMFT system, the acoustic instrument acts as a mediating interface between performer and feedback, allowing for "novel explorations of its (the mixer feedback's) complex, non-trivial interaction space" [8]. However, unlike Elia and Overholt's project——which focuses on mapping, control, and recalling settings—the IMFT emphasizes collaborative human–machine interaction and the emergent sonic affordances of shared feedback performance.

Although performers in the IMFT system can collaborate, they may also work against one another. Novak [15] notes this performance practice among noise artists—particularly those in Japan—working with chaotic feedback, stating that "its (feedback's) modes and techniques are abstracted beyond self-expression beyond even the flexible constructs of improvisation and experimental sound. Noise is more than merely indeterminate: it is out-of-control" [15]. This noise-centered aesthetic goes beyond ideas of controlling feedback [10, 18, 22] and aligns itself in the negotiation with semi-autonomous chaotic feedback systems [7, 16, 19, 23]. This out-of-control performance practice is one of the three ways to approach performance with the IMFT system. These three performance practices draw from no-input mixer performance practice.

2 No-input Mixing Performance Practices

As no-input mixing has evolved, three distinct performance practices have emerged, characterized by varying degrees of interaction with the mixer's controls. These three performance practices are available to the mixer performer within the IMFT system.

2.1 Life on its Own

The first performance practice is a minimalist approach where feedback loops autonomously shape textural development with minimal performer interaction. Toshimaru Nakamura is known for this approach, stating "the unpredictability of the instrument requires an attitude of obedience and resignation to the system and the sounds it produces. Bringing a high level of indeterminacy and surprise to the music" [14]. Marko Ciciliani similarly states that letting the mixer "live a life on its own" offers interesting sonic outcomes [3]. Many no-input mixer performers have highlighted this "joy of the unknown" as a key appeal of mixer feedback [2, 12]. This approach is among the most accessible and widely used performance practice option [12].

2.2 Manipulation with Intent

The second approach aligns more closely with traditional performer-instrument relationships, where the performer manipulates the no-input mixer with clear intent. As one artist, Andrew Leslie Hooker, states, "I've played it for so many years that I can control it [...] I have a large amount of control over the mixer"[12]. Achieving this level of control over mixer feedback is challenging, requires time to master, and will likely change when performing on different models of mixers. Another example is Hannes Seidl's *mixtape* (2013) [20], a scored composition for four no-input mixers. In *mixtape*, specific sounds, gestures, and textures are recreated with each performance. While this work calls for specific actions, it does not notate precise pitch, likely because this level of precision would be improbable.

2.3 Out-of-Control

The notion of relinquishing control in feedback systems aligns with noise artists, who, as Novak describes, do not really play their instruments but instead battle against them [15]. This out-of-control performance practice represents a maximal approach, where the mixer performer is constantly interacting with the instrument's faders, dials, and buttons. Despite constant manipulation, the performer often lacks clear intent or predictable outcomes. Instead, the performer actively disrupts the mixer and instrumentalist, seeking constant change and interference. This approach is conceptually the noisiest in that the main goal is interference and disruption. While it is possible to take all three approaches when working with the IMFT system, the out-of-control noise-centered practice is the least explored in electroacoustic music.

3 Exploring a Feedback Loop

This section presents a method for exploring the no-input mixer and illustrating common sounds produced by the system. In a no-input mixer, feedback emerges when any output is patched into an input. In this example, the mixer's main output is routed into a channel's line input. As the channel strip's (Figure 1) volume fader increases, it crosses a threshold, amplifying the mixer's resonance to produce a high-pitched, quasi-square wave (Figure 2).

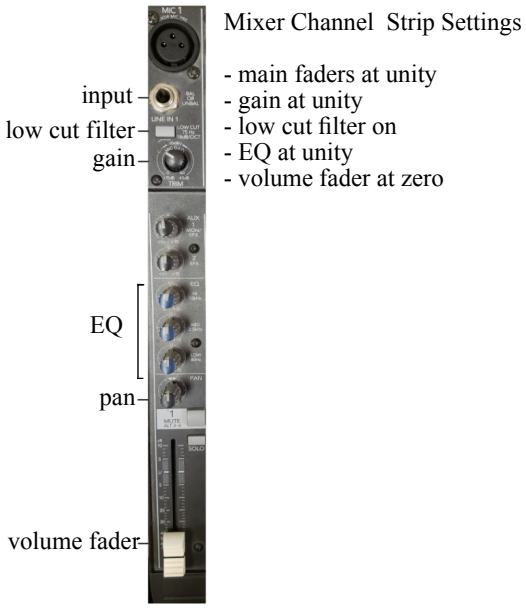

Figure 1: Channel strip from Mackie 1402 VLZ Pro.

From here, several options become available to control the sound:

- Raising the volume fader to maximum can lower the pitch.
- Turning off the low-cut filter causes the pitch to drop significantly.
- Panning the signal often causes unpredictable changes, such as pitch shifts and sound dropouts.
- With the low-cut filter on, pushing the gain knob beyond unity initially raises the high quasi-square wave pitch before it breaks and drops into a lower bass frequency.

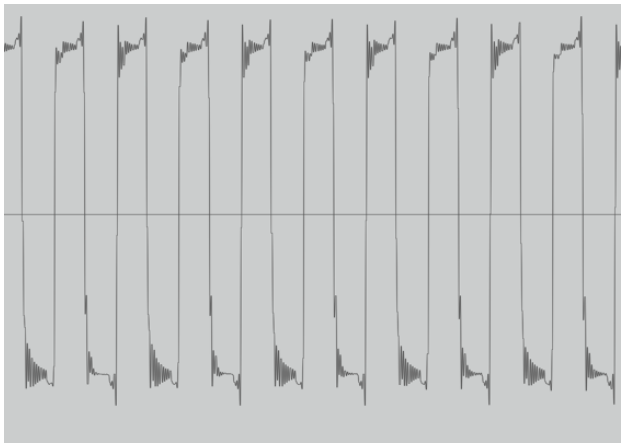

Figure 2: Waveform image of a quasi-square wave.

Changing the EQ parameters changes the point of resonance of the feedback in an intuitive way: increasing the gain on the low EQ band causes the pitch to lower. However, if all EQ knobs are increased to maximum, and the gain is increased, we begin to hear distorted, quasi-repetitive musical loops created by the feedback (Figure 3).

Feedback loops that are generated without any external input are categorized as positive feedback, meaning they are self-reinforcing and constantly changing over time [2, 12, 15]. This behavior gives the impression that the feedback is semi-autonomous. Panning these loops can cause the rhythmic patterns to morph into different, non-rhythmic textures. Turning off the low-cut filter can transform the musical loops into extremely slow oscillations that are amplified to create consistent clicking rhythms. However, as the number of feedback loops increase, they begin to influence each other, and the techniques outlined become increasingly unreliable.

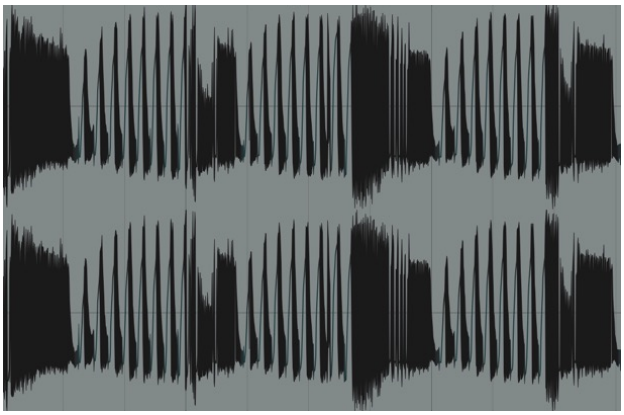

Figure 3: Waveform image of the quasi-repetitive musical loops.

As the number of feedback loops increase, the mixer increasingly displays semi-autonomy. A performer can simply turn up the faders and the mixer feedback will generate constantly changing rhythms, timbres and gestures. When an instrumentalist is patched into this analogue feedback network, their timbre is distorted and their musical gestures interact and augment the feedback. This raises the question: how should the IMFT system be classified?

4 What is IMFT?

The IMFT system is a chaotic, interactive electroacoustic system. To be chaotic, an electroacoustic system must contain nonlinear (positive) feedback loops [21]. The IMFT system is unique because the instrumentalist not only influences and augments the feedback, but also affects the mixer performer, who in turn further augments the semi-autonomous feedback [9]. Sanfillipo and Valle's account of performer engagement with feedback systems is an apt description of how performers interact with the IMFT system [19]:

"The performer can trigger the system (acting like trigger); contribute to perturbing the environment by producing or modifying sounds (that is, becoming a part of Environment);...in order to vary system parameters (as in the control signal flow) or to make the system change its state (like the meta flow). As the performer is theoretically a black box, the analytical treatment of his or her behaviour, with respect to the other components of the feedback configuration, may be very complex and lead to ambiguous findings."

Although Novak contends that the out-of-control relationship in noise music inhibits self-expression [15], the IMFT system

enables performers to engage with it using their instrument of choice, thus fostering greater opportunity for self-expression, virtuosity, and meaningful interaction. However, if the mixer performer takes an out-of-control performance approach, it can also undermine instrumentalists' musical gestures and self-expression. An instrumentalist interacting with the IMFT system in a virtuosic manner opposes the "anti-virtuosity" [12] stance put forward by Nakamura and others.

4.1 IMFT System

The IMFT system (Figure 4) is most effective in duo situations involving one instrumentalist and one mixer performer. The instrumentalist's input signal needs to be quite strong to influence and interact with the mixer feedback. The performers can then set up feedback loops in the remaining channel strips. As with no-input mixing, the more feedback loops that are used, the more complex and unpredictable interactions with the IMFT system become. In the author's experience, two to three feedback loops often yields the best results.

4.2 IMFT Sound

The IMFT system reflects the broad range of sonic possibilities inherent in no-input mixer performance, encompassing textures that span from simple, monophonic tones to chaotic, multilayered noise-based soundscapes. In monophonic contexts, the instrumentalist and the feedback circuit merge into a single sonic entity, producing a fused and often ambiguous sound. In contrast, polyphonic textures arise when the instrumentalist and the feedback maintain distinct auditory identities.

The instrumentalist is constantly distorted with the mixer feedback. This illustrates one of the ways the IMFT system acts as an effects processor. The distortion creates blend or spectral fusion between the instrument and the mixer feedback. Spectral fusion "considers the quality of sound of a number of integrated components into a single sonic entity and attributed to a single real or imagined source" [11]. In other words, the timbre of the feedback and the timbre of the instrument merge into a unified distorted sound world. Like the chaotic feedback systems used in noise music, distortion is a core audio effect when working with the IMFT system. Beyond this, the IMFT system produces interesting incidental processing of the instrumental input, including effects similar to harmonization and pitch shifting.

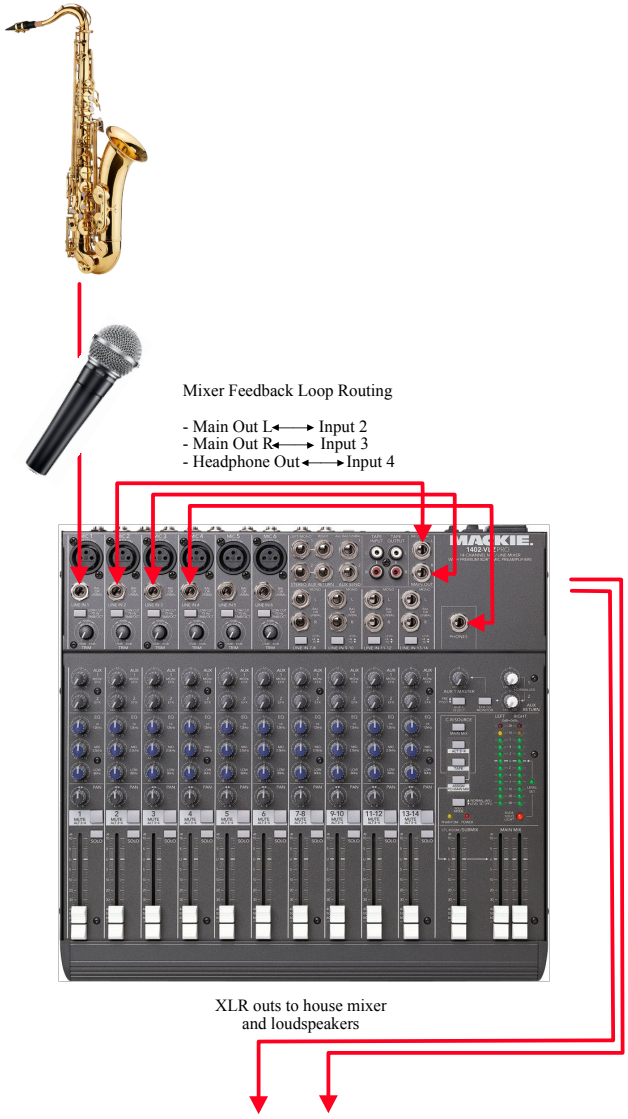

Figure 4: Setup and routing of IMFT system used in the example works discussed.

5 Example Works

Over the last three years, the IMFT system has been the basis for numerous compositions, improvisations, and performances featuring a variety of performers and in a number of musical settings. A comparison between two of these compositions from Nolan Hildebrand—*generative open graphic score #1* (2023) and *noise ritual* (2023)—provides insight into the numerous factors to consider when performing in varying musical styles and with different instruments. In both works, the instrumentalists interpret the open graphic score, while the mixer performer freely interacts with the mixer to manipulate the feedback together with the instrumentalist.

5.1 generative open graphic score #1

generative open graphic score #1 is a piece for a solo instrumentalist and mixer performer with the IMFT system [9]. The open graphic score creates an improvisatory electroacoustic environment. The work has received multiple saxophone interpretations from different performers, both in Canada and Germany, with the mixer for all interpretations performed by the first author.

In performance, two to three feedback loops were used. One notable interaction is the instrumentalist's ability to influence the quasi-repetitive musical loops. For example, input from the saxophone can cause the loop to change in speed. In the most recent interpretation, the saxophone's amplitude affected the speed of a simple clicking musical loop created by the mixer: the harder the saxophonist blew, the faster the loop played. In another interpretation, a two-voiced texture was created when the saxophonist played in the extreme high range and the mixer feedback played a low bass rumble. The input from the saxophone can control and shift the pitch of the feedback—particularly when playing sustained notes—to create harmonization above or below the played pitch.

5.2 noise ritual

noise ritual is a piece for multiple percussionists and mixer performers with the IMFT system. Although the piece similarly uses

an open graphic score to encourage improvisation, its form is more through-composed than that of generative open graphic score #1, requiring the mixer performer to exercise more control and recreate specific sounds. *noise ritual* was first performed by two percussionists whose outputs were routed into a single mixer (played by the first author), along with two feedback loops. In the second performance, three pairs of performers participated, with each pair comprising one percussionist and one mixer performer controlling one to two feedback loops.

A drum hit into the IMFT system can cause the feedback to cut out temporarily, creating a side chain effect. In contrast to the saxophone, a drum attack does not seem to affect the pitch of the feedback loops. During the first performance, the mixer performer would often manipulate the pitch of the feedback in tandem with the instrumentalists' gestures to create a more pronounced interaction. Longer, sustained sounds—such as singing into instruments, bowing a gong on a drum, and rubbing drumheads with superball mallets (all outfitted with contact microphones and patched into a mixer with feedback)—were more effective in manipulating the feedback.

A melodica was similarly outfitted with a contact microphone. When the melodica and the mixer performer both played simultaneous drones the melodica player's drone augmented the pitch of the feedback and at times, broke up and interfered with the mixer feedback drone as well.

6 Discussion

From performances of *generative open graphic score #1* and *noise ritual*, several trends emerge regarding the interactivity between the performers and the mixer feedback. Sounds that produced a clear, sustained pitch—most notably those from the saxophone, singing, and sustained superball rubs—were much more effective than non-pitched instruments with shorter envelopes. Interestingly, sustained gestures from the melodica produced a different effect. This unexpected outcome highlights the unpredictability of working with the IMFT system, requiring the mixer performer to adapt their performance practice according to the instrument type.

When playing the mixer in *noise ritual*, performers must utilize the manipulation with intent approach to accurately follow the prescribed sounds, gestures, and overall form of the work. This requires performers to have a basic understanding of how manipulating the mixer's controls would affect the feedback. However, because there is less inherent interactivity between striking drums and the mixer feedback, the mixer performer often assumed the other two approaches to increase the perceived level of interaction. For example, during the opening section of *noise ritual*, the word "chaotic" is used as an expressive indication. Here, the mixer performer could take the out-of-control approach to create chaotic interaction with the percussion instrument. Another example is found on pages where the text instruction "mixer solo" appears. In these instances, the mixer performer plays an unaccompanied solo which allows them to choose any of the three approaches.

The open nature of the score in *generative open graphic score #1* allows the mixer performer to take any approach they desire, even within a single performance. The life on its own approach allowed the saxophonists to explore a wider range of sound worlds over extended periods, with less interference from the mixer performer. This, in turn, produces dynamic and unpredictable interactions between the instrumentalist and the feedback. Although the mixer feedback behaves semi-autonomously and co-creates the final sonic output, the mixer performer does not overshadow the instrumentalists as they would in the out-of-control approach. The out-of-control approach was used to create a more chaotic musical situation where the mixer performer's manipulation of the feedback clashed with the gestures of the instrumentalist. In *generative open graphic score #1*, the manipulation with intent approach is also possible but, as previously mentioned, exercising intent and control over the unwieldy feedback remains challenging.

7 Conclusions

A summary of techniques discovered so far in recent compositions offers insights into the diverse sound possibilities of the IMFT system. Working with chaotic feedback systems such as this is emblematic of the out-of-control performance practice commonly heard in noise music. The IMFT system can therefore create a noise music aesthetic within a live electroacoustic context. Working with chaotic feedback systems and engaging in a noise music aesthetic can help composers and performers discover new creative possibilities. For example, the entangled relationships that form between the performers and the self-sustaining mixer feedback when performing in the IMFT system can inspire new ways of thinking about human-machine interaction [4]. The introduction of instruments into the feedback chain illustrates new approaches to practice with mixer feedback and facilitates multi-performer interaction.

The relative simplicity and accessibility of creating complex, unpredictable musical interactions with the IMFT system make for an exciting number of possibilities for future exploration. Further analysis and research is required to understand the complex synthesis taking place between feedback and instrumentalist. Analysis with spectroscopes, for example, can reveal how the sound waves of the instrument and the mixer feedback interact.

In addition, further performances are needed to comprehensively develop and document the interactions and dynamics among the performers within the system. The relatively simple routing makes the IMFT system an ideal candidate for networked performances [12]. Finally, new instruments, in various combinations, have the potential to react to the IMFT system in novel and engaging ways. After collaboration with numerous instrumentalists, we may begin to develop a taxonomy detailing which instruments work best and why. So far, the IMFT system has been used in the frame performing open graphic scores with live acoustic musicians. Yet beyond instruments, the system could work with any number of sound inputs, opening up a limitless number of possibilities for future explorations.

Acknowledgments

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8 Ethical Standards

There are no known conflicts of interest in this project. Although this article contains reflections from public concerts with performers, no human participants were directly used for this study.

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9 Appendix

Video recordings of two performances of *generative open graphic score #1* can be found here:

https://www.youtube.com/watch?v=pmTpuCLIuH8

https://www.youtube.com/watch?v=G7ZFPI3YJm8

A video recording of a performance of *noise ritual* can be found here:

https://www.youtube.com/watch?v=AYr1qVBDHxk