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Sappho in Magnesia

feedback, magnets, motors and noise in the Sapphnetix System

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This paper examines Sapphnetix, a system of instrument extensions developed to explore magnetic interaction in sound production. Working primarily with pianos and piano-adjacent materials, the system investigates how rotating magnetic fields, electromagnetic feedback networks, and mechanical vibration interact with ferrous resonance. These devices use magnetic forces to excite, sustain, and modulate vibration within strings and other ferrous components, exploring the complex sonic behaviours that emerge from these interactions.

The work draws on several overlapping ways of thinking about magnetism as a force that is both ancient and difficult to perceive directly. At a planetary scale, the Earth itself can be understood as a magnetic system generated by circulating currents of molten iron. This field has shifted and reversed repeatedly over geological time, leaving traces in the magnetic orientation of minerals within rock formations. Such processes situate magnetism within deep planetary history and within broader understandings of the Earth as a dynamic system operating on temporal and material scales that exceed human perception (Lovelock 2020).

Magnetism commonly enters human knowledge in ancient Greek accounts of magnetis lithos (stone of magnesia) where stones capable of attracting iron without physical contact are written of (although undoubtedly numerous other cultures encountered this phenomenon throughout human history). These mysterious, magical and crucially nearly invisible forces are alluring…magnetic…a lore within the conceptual experiments presented here that ask how perception and interaction might be configured differently in environments structured by unfamiliar forces. The name Sapphnetix combines the Greek poet Sappho (albeit also my namesake) with the language of magnetism to describe an instrumental approach centred on attraction, resonance, and feedback between materials. Conceptually, the work aligns with feminist posthuman approaches to relational systems in which agency emerges through interactions between bodies, materials, and technologies (Braidotti 2022).

The paper discusses three lines of experimentation within the Sapphnetix system: spinning magnet exciters, magnetic feedback, and vibrational devices. Each function as a practical study through which different aspects of magnetic interaction can be examined in a musical context.

While the systems explored in this paper emerge from the broader experimental electronic and feedback-based practices, my own approach emerges more directly from histories of piano modification, feminist technics, and alternative instrumental practices. As I discuss in greater depth elsewhere (Sappho forthcoming), the piano is not a fixed or neutral object but a continually reconfigured technology shaped by bodies, materials, histories, and cultural relations.

A recurring pattern across these histories is the emergence of counter-techniques: practices that push against inherited assumptions of what the piano is, how it should sound, and what pianistic technique should demand of the body. These counter-techniques emerge both through physical modification of the instrument and through radically altered approaches to touch, gesture, force, and listening.

My first free improvisation teacher, Anto Pett, often spoke about developing prepared piano techniques in Estonia during Soviet occupation without knowledge of John Cage's earlier explorations (Sappho, 2023). This reminds us that the impulse to open, prepare, retune, dismantle, and otherwise reconfigure the piano repeatedly emerges across radically different contexts. Burmese Sandaya similarly transformed colonial pianos through retuning and alternative embodied techniques (Webster 2013), reshaping the instrument through entirely different sonic and physical relationships.

Counter-techniques also emerge through transformed approaches to playing itself. Galina Ustvolskaya's music was formative in my own understanding of the piano, revealing a pianism rooted in force, weight, density, and power, far removed from ideals of refinement, obedience, or effortless virtuosity. Annea Lockwood, Andrea Neumann, Magda Mayas, and Lucia Dlugoszewski have similarly challenged the instrument's presumed stability through preparation, dismantling, and extended technique. Across these approaches, the piano shifts from a stable tool of mastery toward a volatile body of resonance, friction, instability, and sonic possibility.

These histories are central to my thinking around feminist technics and counter-techniques, where the focus shifts from virtuosity, control, and optimisation toward relation, sensitivity, instability, and care. The magnetic systems discussed here emerge from these lineages, asking how magnetism might further reconfigure the piano as a relational ecosystem of resonance, attraction, and feedback.

Iteration: Étude Design

The instruments discussed in this paper emerge through a process I describe as étude design: a methodological approach in which small experimental devices are developed to explore specific material, embodied, and sonic interactions. Rather than producing a single finished instrument, this approach generates an ecosystem of experiments investigating physical phenomena central to a wider question at the heart of my practice. Each device isolates a particular relationship within the system, between magnets and ferrous strings, pickups and feedback circuits, or mechanical vibration and resonant surfaces. These studies are no less instruments than the wider system; instead, they act as iterative pathways through which behaviour becomes legible over time.

Étude design resists conventional models of instrument engineering oriented toward optimisation, repeatability, and control. The goal is not to eliminate instability or resolve friction, but to work through them. Each iteration becomes a study in relation: an opportunity to understand how gesture, material, force, resonance, and feedback co-produce one another. In this sense, the instrument is never fully finished. The process of building is inseparable from the development of pianistic practice itself; each iteration reshapes touch, gesture, listening, and the conditions of performance. As with the counter-techniques discussed earlier, the work is concerned not only with modifying instruments, but with transforming relationships to touch, listening, gesture, and pianistic technique. This approach extends ideas from my work on feminist technics and instrument design (Sappho forthcoming).

This approach draws on a broader orientation in my research toward relational systems and material entanglement. Whether through systems thinking (Deleuze and Guattari 2004; Ingold 2008; Latour 2005), concepts of intra-action (Barad 2007), or my own work on systems, technology, and social interaction auto-sociologically (Sappho 2025a), agency is understood not as something possessed by discrete objects but as something that emerges through relation often entangled with technologies. Instruments, performers, materials, and technologies do not operate as isolated entities but continuously co-constitute one another through interaction. The systems discussed in this paper are best understood in these terms: networks of intra-acting elements in which magnetic force, sound, energy, gesture, feedback circuits, resonant surfaces, and audiences collectively shape the behaviour and evolution of the instrument.

System I: Spinning Magnets

The first line of experimentation within the Sapphnetix system emerged through a device I built called the Ostoyae (MacGlone 2023). The instrument formed part of an earlier period of research exploring interactions between biological organisms, machine systems, and human performers with a particular interest in how non-human agents might participate in musical systems, attempting to make legible the role of the more-than-human as something beyond symbolic or aesthetic. In which I was experimenting with ways that fungal networks might interact with instrument design through my work in mycomusical and ecological sound systems (Sappho 2025b, Sappho Forthcoming).

The Ostoyae instrument allowed fungal bio-signals to influence the tuning of a stringed instrument through a modified electronic tuning system. In this configuration the fungal network could alter the pitch structure of the instrument while I performed on it. However, the organism could not directly activate the strings themselves. This limitation produced a conceptual problem. If the project was intended to explore distributed agency between human, machine, and organism, the instrument still privileged the human performer as the only actor capable of exciting sound, that is; even with the ability to change the pitch of a string, the string needed to still be activated for this microtonal shift to be made audible.

I encountered several devices developed to excite metal strings using rotating magnetic fields. These systems are sometimes compared to EBow-type technologies, although the underlying mechanism differs. The EBow sustains vibration through an electromagnetic feedback circuit creating a magnetic field vibrating the string. Rotating magnet systems instead rely on mechanical motion. In this system magnets are attached to a motor-driven rotor and spun close to a ferromagnetic string. Rotation causes the magnetic field around the string to vary in orientation and strength, producing periodic attractive forces between the magnet and the steel string. When this variation approaches one of the string's natural vibrational modes, energy transfers into the string, initiating vibration without physical contact. The system's behaviour depends on interacting parameters, including magnet–string distance, motor speed, and the magnet's position relative to the string's modal structure. Under suitable conditions, the rotating field acts as a localised driver, producing either stable sustained tones or beating patterns from interactions between neighbouring resonant frequencies.

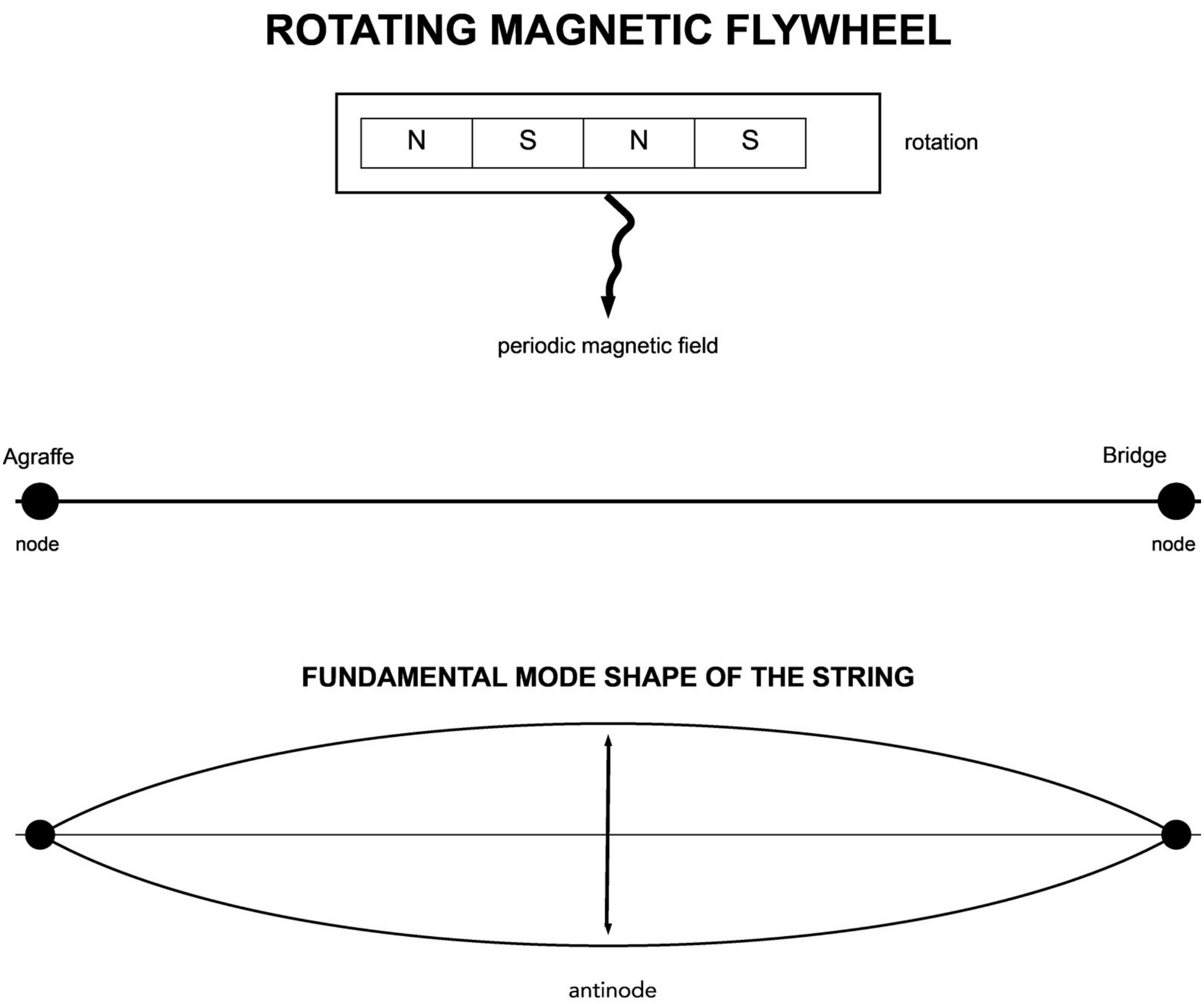

Figure 1 – How a magnetic spinning flywheel functions

This approach appears in instruments such as the DuoFluctus (Filatov 2019), and the installation 'String Resonator for Room' (Jablonski & Rickman 2019) which both employ a rotating magnetic flywheel positioned beneath mounted strings. And examples of handheld instrument extensions i.e. Ferrous by SF builder and Victoria Shen (Kirn 2024). These systems share conceptual ground with electromagnetic excitation instruments as Andrew McPherson's Magnetic Resonator Piano, although like with the Ebow the Magnetic Resonator Piano employs computer-controlled electromagnets to inject energy into piano strings with considerable precision (McPherson n.d., 2010).

What attracted me to these mechanisms was their simplicity. Much of my instrument design practice relies on inexpensive materials. They are 'simple' in the sense that they rely on basic physical interactions, which makes them incredibly accessible: they are mechanisms that, in principle, anyone could construct from cheap parts, and basic mounting structures. The early prototypes described here therefore should not be understood as attempts to refine or optimise the mechanism itself as more refined devices already exist as above, rather, my experiments functioned as a form of iterative design inquiry through which I explored how this phenomenon might enter my own improvisational practice in different forms, device interactions and applications across different instruments and ideas.

As noted, the first actuator was embedded inside the body of the Ostoyae instrument and controlled through fungal sensing systems that modulated the motor speed. In this configuration the instrument was not navigated directly by my own gestures but by signals generated by the organism. This arrangement reflects an ongoing design principle within my work: allowing other agents to participate in navigating the behaviour of the instrument rather than positioning the performer as the sole activator of physical world sound.

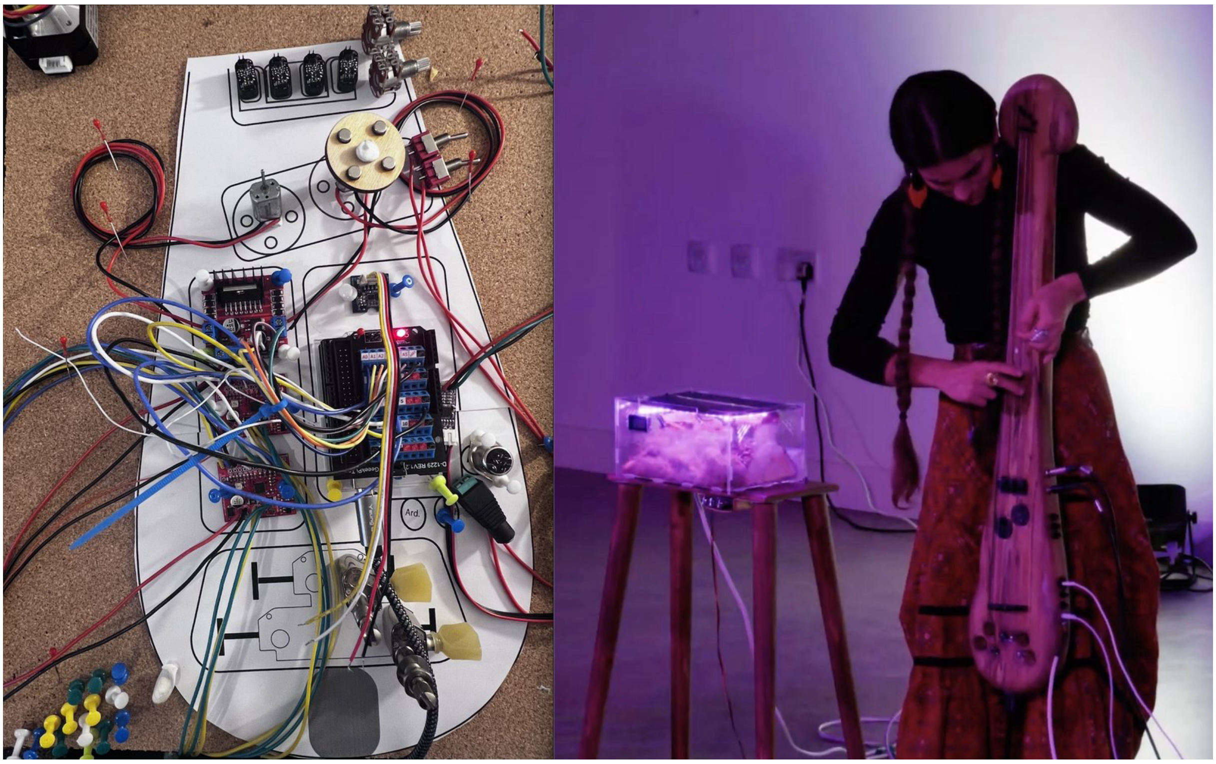

Figure 2 – Ostoyae, electronics left, and finished instrument right

Subsequent versions explored more direct embodied interaction. Handheld devices were developed (some as simple as mounting magnets on a handheld fan) that allowed rotating magnets to be moved freely across a range of ferrous string instruments commonly used in my improvising practice. These tools functioned primarily as exploratory devices for investigating how magnetic excitation behaves under different spatial relationships between performer, actuator, and string. In practice, however, the handheld designs proved difficult to control reliably. Maintaining the narrow distance required for stable resonance demanded constant attention, the interaction could be easily lost, or the magnet rotor would strike the strings. Questions about how the actuator might function as an extension of the instrument, the body, or both became an important consideration within the subsequent development of the project and are discussed further later.

Figure 3 – two handheld spinning motor device experiments

Through these iterations these experiments gradually evolved into more specialised spinning magnet modules designed specifically for interaction with piano strings, which are now mounted onto the frame of the piano with control over speed accessible from the players position at the keyboard. Rather than controlling position continuously during performance, the performer instead shapes the behaviour of the system primarily through small adjustments in motor speed and through the use of the piano's sustain pedal. In this arrangement the instrument itself effectively holds the actuator in the correct spatial relationship to the strings, allowing the performer to focus on subtle changes in the conditions under which resonance emerges.

What interested me about rotating flywheel magnets in this context, is that the system operates through comparatively unstable physical relationships between motor speed, magnetic orientation, and the resonant properties of the strings. Rather than sustaining stable tones, rotating magnets tend to excite delicate and often unstable resonances within the string system. Small changes in rotational speed can dramatically alter the resulting sound, producing moments of harmonic emergence, beating interactions between strings, or sudden collapses of resonance.

Within the piano this behaviour creates a performance situation that demands extremely close listening. Very small gestures, sometimes only a few millimetres of movement in the motor control or slight adjustments of the sustain pedal, can cause entirely new sonic behaviours to emerge within the instrument. In this sense the performer is not so much producing sound through direct action as carefully navigating a set of resonant conditions already present within the instrument. Sustaining a particular sonic state often requires remaining almost perfectly still, allowing subtle interactions between the rotating magnetic field and the piano's string system to unfold over time. The following video example demonstrates this interaction within the piano with the most recent version of the system.

Video 1: https://youtu.be/CHwBdYdPWhU

System II: Magnetic Feedback Piano

While developing the Ostoyae I was also considering amplification and electromagnetic systems for non-traditional string instruments. For example, the Halldorophone, which uses electromagnetic pickups and feedback circuits to generate controllable resonant interactions between the instrument and an external amplification system (Úrlfarsson 2019). Following this example, I began experimenting with NU electromagnetic pickups. These early experiments were somewhat over-engineered, requiring more hardware, routing, and technical complexity than the musical results justified, but they marked an important shift in my attention toward electromagnetic approaches to the piano. More importantly, they got me thinking as a pianist about electromagnetic pickups and their wider possibilities.

The Helpinstill pickup system uses magnetic pickup bars positioned beneath the strings to amplify the instrument for stage performance, particularly in situations where microphones are impractical due to bleed, feedback, or the difficulty of isolating the piano within an ensemble. And Scott McLaughlin introduced me to his piano feedback system, an adaptation of EBow-type technology developed for piano performance (McLaughlin 2025).

Having previously used magnets as fluid piano preparations, I began to consider their interaction with electromagnets. I suspected there might also be interactions between the pickup's electromagnetic field, the preparation magnets, and the ferrous piano strings. In early experiments, I found that while moving the pickup around the magnetically prepared strings, unstable resonances could be amplified and the system would often begin to generate new feedback tones. By specifically placing speakers or amplifers within this environment a significant factor of shaping this behaviour could be developed.

I began designing a set of feedback-based pickup gloves. These gloves allowed the pickup to be moved dynamically above the piano strings, enabling an embodied exploration of the electromagnetic relationships between pickups, magnets, and the ferrous strings of the instrument.

In Video 2 I explore different configurations of magnets and piano preparations placed directly on the strings, with the pickup gloves hovering above these magnets and the Helpinstill pickup system positioned beneath the strings, while an amplifier is directed into the body of the instrument. Through these experiments I began to understand the practical playing possibilities of the system, particularly the behaviour of feedback pitch and harmonic resonance within a specific ecosystem I might build and the importance of distinct factors to each setup: damper condition and contact with the strings, pedal position, and the sympathetic resonances that emerge through different magnets, positions of interaction, simple preparations including wooden chopsticks and Blu-Tack, and the room itself.

Video 2: https://youtu.be/qn3gAz90R5w

From my current understanding, placing small magnets directly on the piano strings modifies the local magnetic field in the region sensed by the pickup. At the same time, the magnet is a preparation: its mass and the magnetic attraction between magnet and string alter the vibrational behaviour of the string itself. While feedback can be produced without magnets placed on the strings (i.e. the magnetic resonator piano), the sonic diversity of strings prepared with a magnet where what intrigued me the most.

These interactions are influenced by the vibrating string because the pickup responds to changes in magnetic flux produced by string motion, the system becomes most sensitive at specific harmonic locations. Small adjustments in the distance between pickup, magnet, and string can therefore significantly alter the behaviour of the system, shifting the feedback interaction between stable amplification, beating tones, and unstable resonant oscillation, while also providing a dynamic system which can be moved and explored live.

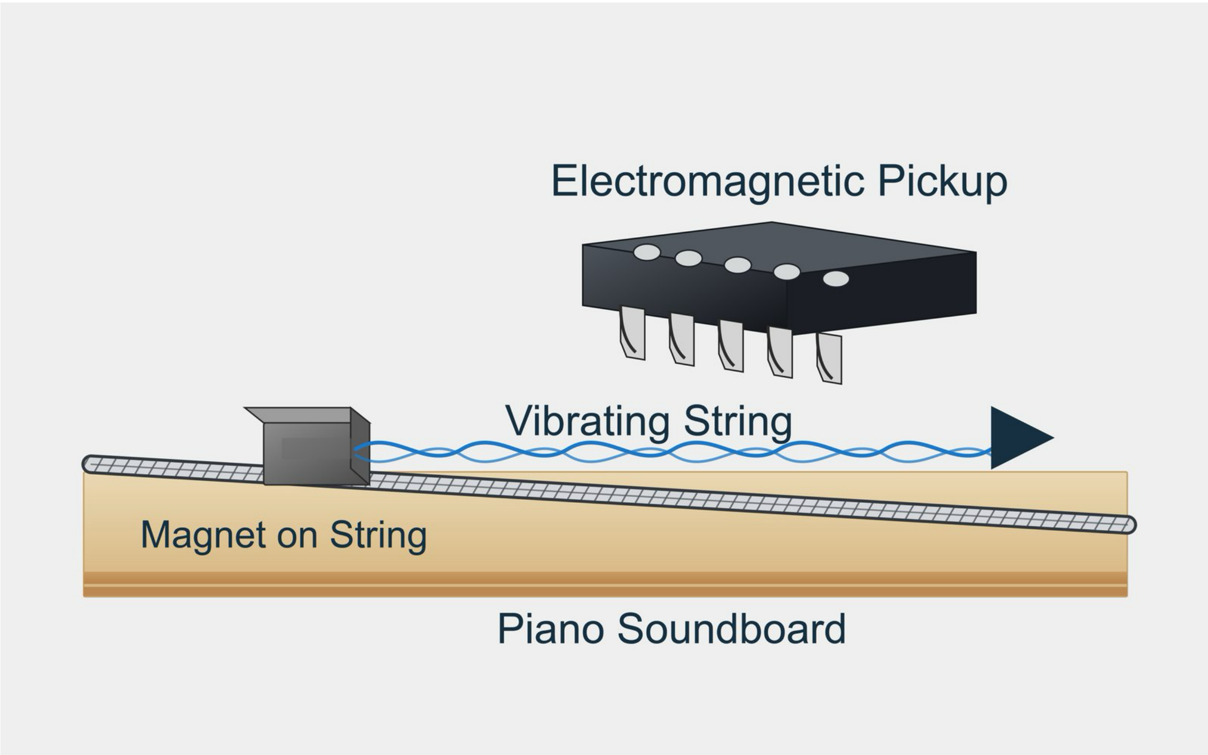

Figure 4 – electromagnetic magnet feedback system for Sapphnetic piano

At this stage the system existed as a handheld device (barring the Helpinstill under the strings) so that I could develop these experiments by moving across the piano strings.

The next series of experiments explored how portable the system could become from a practical reality: this system is really only well suited to a horizontal piano (baby grand or bigger) which are often not abounding in many experimental music venues, nor accessible in bigger concert hall spaces due to a inherent fear of harm of instrument through piano preparations (Sappho forthcoming). But like many pianists who play inside the instrument (i.e. Andrea Nuemann) I was not particular in need of the keyboard of the piano. So several solutions developed over my practice so I might share the Sapphnetix practice in various concert settings. For example, I added a piano harp: cast-iron frame and strings removed from a discarded piano to my instrumentarium and experimented with instruments similar to the inside of a piano conceptually i.e. I came across a free santoor, whose metal strings provided a similar ferrous resonant structure.

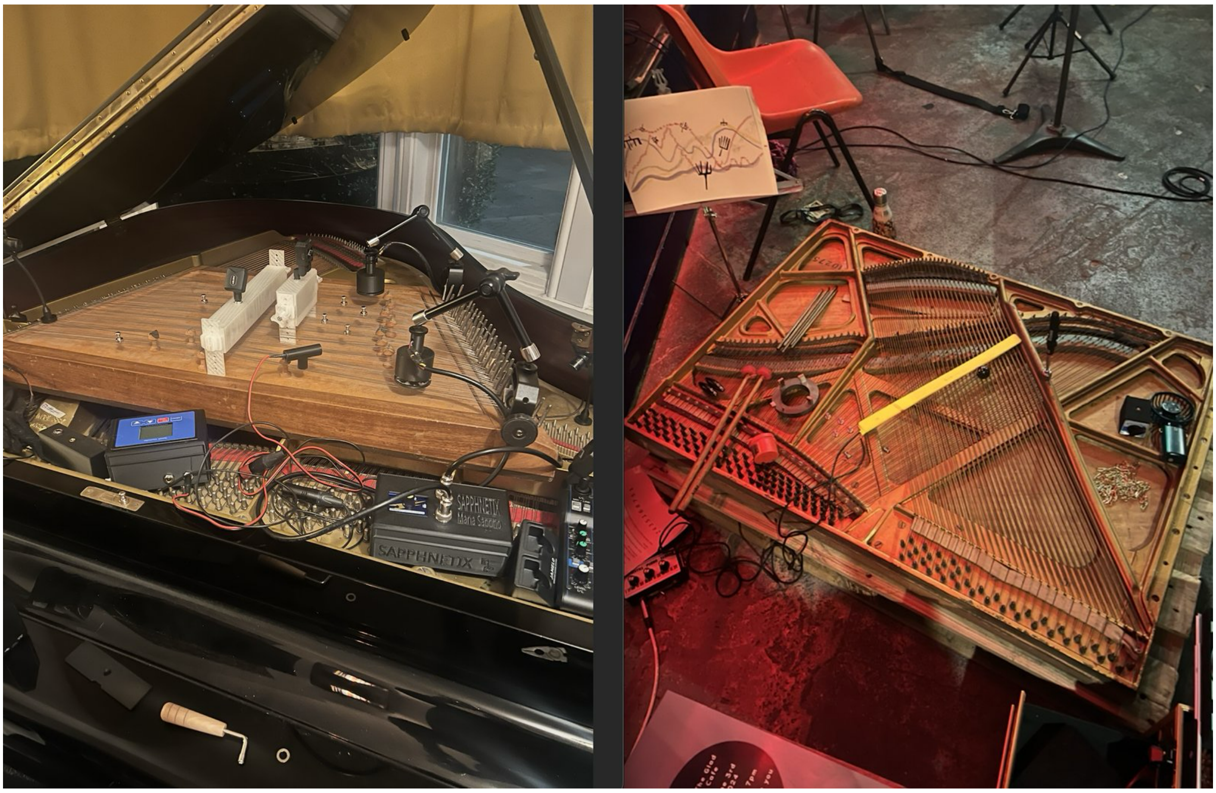

Figure 5 – electromagnetic pickup devices and string instruments (Santoor left, piano harp right)

Eventually I realised that I might possibly not be interested in strings at all, and the system was expanded beyond stringed instruments entirely through the use of large ferrous metal sheets. These surfaces could be prepared with magnets in much the same way and interacted with using the handheld pickup to generate comparable feedback interactions. These metal sheet setups became most useful in large international trips, i.e. premieres in Indonesia and South Africa.

Figure 6 – Large ferrous metal sheet used as resonant surface

Video 3: https://youtu.be/8QyX5Ue2aYA

Through these experiments I realised that I could simplify the setup even more, what obviously mattered was the presence of ferrous material capable of interacting with the magnetic field of the pickup. Which led to the smallest version of the system consisting of two handheld devices: a magnetic pickup in one hand and an electromagnet in the other. In this configuration the electromagnet could excite the metal surface while the pickup captured and amplified the resulting vibrations.

I was nevertheless still committed to exploring this with the piano, which if a grand piano was accessible allowed me to develop further pianist exploration of the instrument both with the larger frame and resonance of the body and the keys and dynamic control with pedals. And yet through my explorations with the glove or handheld versions of the system, I began to be interested in mounted forms of the instrument like those that I was developing for the spinning magnets. In this case again, the extension of my body often was not the necessary component, I began constructing stabilised pickup modules designed to be mounted directly within the piano. These modules allowed precise positioning relative to magnets placed along the strings.

Figure 7 – Sapphnetix system installed Meet Music Code festival, Lugano, March 2026

Audio 1: https://www.mariasappho.com/magnesia

System III: Vibrational Devices

The third line of experimentation within the Sapphnetix system explores an even more direct mechanism for exciting resonance in ferrous materials: mechanical vibration. Despite their simplicity, these additions have continued to be a beneficial added dimension of the magnetic and resonant interactions and contribute to a broader field of piano and experimental experimentation, for example Perini's 'Epicentro' (Perini 2020).

My earliest experiments, amongst many experimental musicians, re-purposed existing vibrating systems, mostly toys. Kids toys and cat toys and sex toys. Sex toys are great devices because they are developed to be ultra quiet, easily charged, and can often come with a range of vibration settings and even remote-control activation. I have always enjoyed the aesthetics of this mix of toys, both for their odd connotations that they carry which in many ways evoke taboo.

The notion of taboo in particular seems deeply attached to the development of this practice, from the overt reference to Sapphic histories, to the ethics of sex toys in various performance, workshop, and public spaces, to the idea of the sounds that emerge from the Sapphnetic practice more broadly: intentionally designed around sounds that historically are considered 'noise' or undesirable in relation to a broader history of noise and gender sound studies (Sappho forthcoming).

In general, my exploration and development of vibrating motors of all kinds continues to be a core development of my Sapphnetic practice. Including various experiments like my Tardigrade shaped object that is mounted with a XIAO seed microcontroller (a compact microcontroller used for sensor processing) which connects to a simple web app for remote control for various parameters of vibration.

Figure 8 – Tardi grade vibration device (xiao remote control equipped)

Video 4: https://youtube.com/shorts/fiySRhkYb7g?feature=share

With this in mind, I built a piano for a children's exhibition at the Maker World in Huddersfield (2025) when I came across a piano that was abandoned in the venue. I did not go to the installation with the intention to interact with a piano, but as there was one in the space, and I thought it a shame not to bring it to life. The installation used simple PIR sensors (motion sensors) connected to relay circuits that activated the vibrating motors when young people approached the surface. When the system was triggered, the vibrating devices would begin exciting resonances across the piano. I called it the Grumpy Piano, continuing the piano joke…the 'Ill tempered piano', 'Bad Tempered Electronic Keyboard', and 'The Short Tempered Clavier' (Bach n.d.; Cipani 2008; Ginsburgh n.d.). A piano that has been left in a cold exhibition space for so long most people don't even remember it is there anymore, it is grumpy and out of tune. But moreover, it is the activation of this kind of grand and stately instrument, through experimental practice, in the hands of young people. That is, these sounds might sound grumpy, because our society often associates noise with negative emotions, but in the hands of children, a game, silly, a piano brought to life, and performed in a wonderful, entangled relationship between children's exploration and incredibly simple remote onset piano activation.

Video 5: https://youtube.com/shorts/wtotYVevRyA

More recent designs integrate magnets directly into the vibrational devices themselves. By embedding magnets within the vibrating motor housing, the devices can interact simultaneously with the magnetic systems described in the previous sections. This configuration allows the vibrational actuator to both excite the material mechanically and interact magnetically with ferrous surfaces and pickups within the system.

These hybrid devices further extend the iterative design process underlying the Sapphnetix system. Rather than functioning as standalone instruments, they act as exciters that can be placed across different resonant materials within the system. In performance contexts they are often deployed at a distance from the performer, allowing the instrument to appear to 'play itself' as the vibrating devices activate resonant behaviours across the surface.

This aspect of the system aligns with the broader methodological framework described earlier in which instruments are treated as networks of interacting components, together with the spinning magnet devices and magnetic feedback systems, these vibrational exciters contribute to a broader exploration of how resonance can be activated across metal surfaces through different forms of physical interaction. Each system introduces energy into the material in a different way, rotating magnetic fields, electromagnetic feedback loops, or direct mechanical vibration, together they help me explore new behaviours within the same underlying network of ferrous resonance.

Video 6: https://youtu.be/CjO3gRGTG8c

Video 7: https://youtube.com/shorts/2RSmQqc6eu8

Magnetism as Instrumental Method

Across the three systems, magnetism functions not only as a physical mechanism but as a methodological framework for experimental instrument design and relationship with instruments. Magnetism is especially generative here because it operates relationally through attraction, repulsion, distance, and invisible fields of force. Each introduces energy into ferrous materials differently, yet all share a core principle: sound emerges through the interaction of multiple material forces rather than the control of a single actuator or agent.

Within this framework, the instrument is not a stable object but an evolving configuration of relations. Magnets, motors, pickups, resonant materials, performers, and environments all shape the resulting sound. The Sapphnetix system therefore operates not as a singular instrument, but as a network of interacting forces. No single element acts as sole controller; agency instead emerges through interaction.

This relational structure produces the instability that characterises the system in practice. Magnetic feedback interactions are highly sensitive to spatial configuration: small changes in distance, orientation, or environment can radically alter behaviour. A slight shift in a pickup, a displaced magnet, or a change in acoustic conditions may collapse a resonance or generate unexpected harmonics. These dynamics reflect the nonlinear behaviour of feedback musicianship systems more broadly, where small perturbations produce disproportionate sonic effects that the player remains in constant negotiation with (Magnusson et al. 2022).

Instability here is not simply a technical limitation to overcome but a compositional and methodological condition. The system produces knowledge through drift, friction, and unpredictability. Each performance becomes an act of negotiation in which listening, adaptation, and responsiveness are prioritised over precision and control.

Such instability makes the system difficult to reproduce across performance contexts. Even when carefully set up, it shifts over time, and each new instrument, room, or technical setup produces a fundamentally different system, an entirely new ecosystem requiring recalibration. Transporting the system also creates friction with institutional infrastructures: magnets, batteries, and vibrating components often attract attention at airport security, while venues may be cautious of these practices. The work itself requires slow, careful setup, often hours, standing in sharp contrast to performance traditions that value immediacy, portability, and virtuosity. In this sense, the practice aligns with a feminist technē that resists the expectation that a pianist should simply 'sit down and play' (Sappho forthcoming).

Approached as a constellation of etudes, experiments unfolding across materials and interactions, the Sapphnetix ecosystem continues to evolve through both performance and ongoing development. The next iteration draws on drone technologies: extending the drone motor driver system already used to power the magnets, and exploring parallels between drone operation, remote and gestural control, and the system's own modes of interaction. It also engages with the broader cultural and political dimensions of drones, as hobbyist devices, creative tools, a musical style, and instruments of surveillance and warfare (Pong & Richardson 2024; Quicho 2021).

From this perspective, the Sapphnetix system continues my commitment to soft revolutions against pianistic, Western musical, and gendered biases. It challenges deeply embedded assumptions that instruments should reward mastery, efficiency, and control. Instead, the system privileges sensitivity, attentiveness, care, and relation. By inviting audiences to engage with the system directly, it becomes clear that while the actions are not inherently difficult, they demand heightened attention to listening, noticing, and delicate gesture. The instrument emerges through this relational encounter.

Magnetism therefore becomes more than a means of producing sound. It becomes a way of thinking through instrumentality differently: as relational, distributed, unstable, and contingent. In Sapphnetix, sound emerges not through mastery over an instrument, but through ongoing negotiation with a dynamic ecosystem of forces.

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