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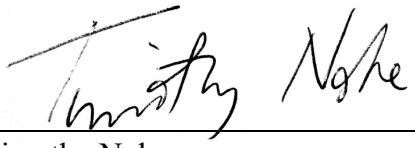
Thesis and Abstract Approved: 

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ABSTRACT

Title of Document:	RECIPROCATION
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The sculptural works in *reciprocation* repurpose loudspeakers, transforming them from "invisible" aural channels into evocative things to interrogate interpersonal relationships, (mis)communications, and the kinetic phenomenon of sound itself. While recorded audio is used to drive the speakers, the *heard* sound is an artifact of material activated by subsonic frequencies. As the phenomena of sound and hearing are dependent on reciprocal movement, so is our understanding and reflection of the meaning that sound carries. *reciprocation* consists of four works: *fate*, in which two speakers, one positioned vertically above the other, are united by dozens of parallel red threads; *allegory*, in which eight speakers thump against a wall and the restraints holding them up, causing lights hidden within their cones to cast changing shadows around the darkened space; *harmonic curtain*, depicting the harmonic series through a network of connected chains; and *trine*, a triangle of three freely hanging speakers linked by a mesh of fine chain.

RECIPROCATION

By

Jason Charney

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, Baltimore County, in partial fulfillment
of the requirements for the degree of
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Preface

This work reflects a continuing fascination with the interactions of seen and unseen forces and human intentions warped through technological transmission. It's somewhat fitting that the work must be illustrated by digital renderings and studio "in-progress" snapshots, rather than documentation of gallery installation. While the pandemic sweeping the world halts our ability to gather in real places like art galleries, it will certainly remake our mediated relationships with one another. Fortunately, mediated relationships are a core theme of *reciprocation.* I look forward to seeing how the meanings of these pieces evolve when they can finally be experienced in their physical forms.

Acknowledgments

This work would not exist without the support of many people.

Thank you, Kathy O'Dell, Brandon Ables, Mandy Morrison, and Adan Rodriguez for your close readings and great conversation, and the shared determination in realizing our visions.

Thank you to my committee Kathy Marmor, Jules Rosskam, Sarah Sharp, and especially my chair Tim Nohe for your devotion to helping me see this project through.

Thank you, Greg Hatem and Garrett Stralnic, for your support, companionship, and laughter. Thank you, James Young and Allison Clendaniel, for being excellent roommates and continuously inspiring collaborators.

Finally, I'd need 500 more pages to write a sufficient number of "thank you"s to my parents, Gil and Marcia Charney, for supporting my curiosity even if they didn't always understand it. I love you.

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Introduction

Sound is dynamic change. Sound does not happen without motion, starting at its source and echoed through matter in the environment and in the body. Sound is a consequence, a strange byproduct of the constant flow of energy throughout the universe. The phenomenon is a causal chain, in a sequence of three phases:

Excitation: Struck with a burst of energy, an object is set into motion, the force dispersing across its surface. The material vibrates, its oscillations up and down echoing fractally in every particle.

Propagation: The surrounding air molecules pick up the force too. They compress close together and then spread out again, causing the air molecules next to them to do the same. Like millions of bucket brigades, they transmit this wave in all directions from their source.

Perception: The wave propagates into air molecules in the ear canal and hits the eardrum, causing it to vibrate sympathetically. Through a delicate organic system, the wave is turned into electrical impulses that travel to the brain. The brain makes meaning of language, assesses the threats in the surrounding environment, or activates an ineffable emotional response.

The body is where sound is born. Sound is simply motion until the body transforms oscillation into sensation in a messy, subjective process. Like other sensations, sound is a phenomenological experience unique to each sensing being, in spite of its observable and simple physical origins.

Hearing is sympathetic. The wave of air transfers its energy into its surrounding neighbors, eventually reaching the air around the ear. Unlike our eyes with their lids, our ears are always open to the world around us. Hearing is passive.

Listening is active. For every crack of a tree branch in the forest or every note of music, we constantly contextualize as we listen: Is it a threat? Is it grammatical? For every spoken word transmitted to us, we must choose to ignore it or deduce its meaning, reconciling our own understanding of words with what we assume is our interlocutor's intent. Listening is empathetic.

The chain of dependencies between a sound source and an ear is ripe for distortions and occlusions. The materials of the speaker or vocal tract affect the efficiency with which either of these channels can convert electrical potential into physical movement. The obstacles in the room may absorb or reflect the sound waves. Anatomical variations in each ear, auditory nerve, and brain create different meanings from these small changes in air pressure. Some people lack the ability to hear at all because of even a tiny defect in the delicate human auditory system.

I participate in the flow of physical energy: hearing, then listening. I begin the three-part sequence of sounding anew. There is a fourth process that permeates every step of this chain.

Reciprocation: I transmute intention into language and into physical action. I create sound by vibrating my vocal cords, shaping my exhalation with my lips and tongue and teeth, transmitting it through the air to another's ears. Even without the unknowable phenomenological differences in perception, our simple spoken conversation is riddled with entropy and loss. The physical phenomenon of sound and hearing is dependent on

reciprocal movement and mutual exchange. So is our understanding and reflection of the meaning it carries.

Non-Cochlear Sound

Marcel Duchamp coined the phrase "retinal art" to describe work that appealed mainly to the eye, advocating instead for a conceptual turn toward non-retinal art, where the work escapes the boundaries of what is seen in the artwork itself. Seth Kim-Cohen extends Duchamp's "non-retinal" art to the auditory, seeking a conceptual, "non-cochlear sound":

> If a non-retinal visual art is liberated to ask questions that the eye alone cannot answer, then a non-cochlear sonic art appeals to exigencies out of earshot. But the eye and the ear are not denied or discarded. A conceptual sonic art would necessarily engage both the non-cochlear and the cochlear, and the constituting trace of each in the other.[1]

Sound art is a relatively new discipline,[2] but many contemporary artists have turned toward non-cochlear sound in their practice, often requiring the viewer to imagine the experience of listening as much as, if not more than, actually hearing. For example, Christine Sun Kim's charcoal drawings are both *about* sound and devoid of it. The artist's *just music* series (2017) includes several 20" x 25" framed works, each containing an amorphous field of quarter notes. Without staff lines, the notes float on the paper, interrelated only by the curved line slurring them together. The title of each work is written above the notes ("muffled club music" or "royalty free song," for example), suggesting a melodic contour but no other information. [3] These "scores" are not meant to

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[1] **S**eth Kim-Cohen, *In the Blink of an Ear: Toward a Non-Cochlear Sonic Art* (New York: Bloomsbury Academic & Professional, 2014), xxi.

[2] Kim-Cohen argues that "Sound art, as a discrete category of artistic production, did not come into being until the 1980's." Of course, artists incorporated sound into gallery art throughout the twentieth century. Additionally, the conceptual turn to think about "sound-in-itself" was first thoroughly explored in the context of music (Luigi Russolo, John Cage et al) rather than gallery arts.

[3] Christine Sun Kim, "Just Music," Christine Sun Kim, accessed October 27, 2019, http://christinesunkim.com/work/just-music/.

be performed; they are ambiguous suggestions for hypothetical audition. In a series of pithy infographics, Kim's *Degrees of Deaf Rage* series (2019) categorizes and ranks her frustrating interactions as a Deaf person in everyday situations.[4] Though they communicate no sound, Kim's drawings require the viewer to become a conceptual listener to a silent music or to empathize with a hard-of-hearing person's experience in a hearing world.

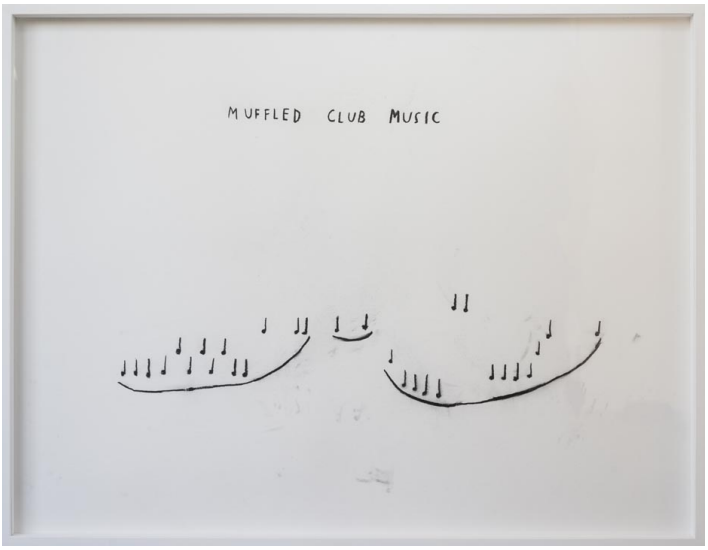

Figure 1. *just music* by Christine Sun Kim (2017).

Bruce Nauman's work *Concrete Tape Recorder Piece* (1968) relies even more on the viewer's visual and sonic imagination to infer the existence of sound. The work consists of a tape recorder wrapped in a plastic bag and cast inside a block of concrete, playing a looped recording of a woman screaming. An electrical cord and plug protrude from the sculpture's side, the only visible evidence to corroborate the piece's title and

[4] Victoria A Valentine, "Whitney Biennial 2019: A Look at 7 Artists and the Works They Presented," *Culture Type*, September 22, 2019, https://www.culturetype.com/2019/09/22/whitney-biennial-2019-a-look-at-7-artists-and-the-works-they-presented/.

description. The viewer must imagine both the sound and its silencing by the block in which it is entombed.[5]

These non-cochlear sound works center around what is *not* heard in order to illuminate the experience of listening. The viewer must consider their own relationship to hearing and the ways through which sound itself is mediated by other societal and technological forces. In non-cochlear sound art, sound events are forefront, but not necessarily sensate.

Other sound artists have more directly established touchstones for my work, strongly considering the non-cochlear while foregrounding speakers and other audio technology as sculptural objects. Rolf Julius created installations that embedded tiny speakers in various quotidian objects such as rusted pipes, paper bags, and tiny bowls, activating their material presence sonically and visually. Often playing sounds at very low volumes, they encourage the listener to get close to hear their sonic content. They also incorporate messy, unhidden wires and media players, such as the portable CD players that lie unassumingly on the ground in *Music in a Corner* (1983).[6] In *Red* (1996), two naked speakers are suspended side-by-side from the gallery ceiling, resting just above the ground. They are coated in a red pigment, which visibly vibrates with the barely audible sound playing through their upturned cones.[7]

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[5] Germano Celant, ed., *Art or Sound* (Milan: Foundazione Prada, 2014), 248.

[6] Joseph Nechvatal, "Music That Is Audible to the Naked Eye," *Hyperallergic*, October 17, 2017, accessed November 22, 2019. https://hyperallergic.com/404008/work-that-is-audible-to-the-naked-eye/.

[7] "Red," Mattress Factory (The Mattress Factory), accessed November 22, 2019, https://mattress.org/archive/index.php/Detail/Collections/107.

Figure 2. *Red* by Rolf Julius (1996).

More recently, Adam Basanta used speakers, microphones, and other sound technology objects as sculptural forms. His *Sounds Not Heard* series (2017-present) consists of various objects cast in pristine urethane resin, crumbling concrete, or simply split in half. For example, *Split* (2017) is a sculpture consisting of a microphone, speaker cone, and amplifier, sliced neatly in half along their lengths and mounted side by side. Their wall-mounted display suggests taxidermy or a didactic diagram about how sound is made. Meanwhile, these unassuming objects are prevented from ever sounding themselves.[8]

[8] Adam Basanta, "Sounds Not Heard," accessed November 18, 2019, https://adambasanta.com/soundsnotheard.

Figure 3. *Split* by Adam Basanta (2017).

My works in *reciprocation* also focus on the non-cochlear while also directly employing sound. In each work, the speakers are driven at low enough frequencies that the sound they make is almost inaudible. However, the materials that connect them may make sound as they are activated by the speakers' movement. The viewer-listener is never able to place themselves directly between the speakers in an ideal listening position. Rather than listen to the sonic outputs as invisible carriers of abstract meaning, the viewer-listener focuses on the physical phenomenon of sound and the relationships implied by the speakers' placement.

The Speaker as Evocative Thing

Speakers and Invisible Power

The loudspeaker is an astoundingly simple piece of technology. An electromagnet is attracted to or repelled from a permanent magnet behind it as the voltage of an electric field – the signal passed down the wire – fluctuates. A paper cone attached to the electromagnet flexes in and out from its resting point at equilibrium, disturbing the air in front of it in waves of changing pressure. Varying the speed at which the cone moves in and out (frequency) and the distance it travels (amplitude), a speaker can precisely reproduce any kind of sound in the range of human hearing.[9]

This simple design begets a ubiquitous and multivalent instrument of power. The commanding public address system in an arena adds authority to a politician's message through its physical presence alone. The weapon-like protrusion of a police officer's megaphone carries an implicit threat beyond its ability to amplify their voice. Certain speakers are used for their ability to cause dread and even disrupt bodies; some sonic weapons generate acoustic waves outside of the human range of hearing with enough force to cause nausea or burst eardrums.[10] The speaker is also a channel for more banal control. Walking into a public place of commerce, it is rare to encounter a sonic environment unaltered by speakers. Carefully curated music plays from hidden sources at

[9] Typical human hearing range is from 20-20,000 Hertz, a unit of frequency equivalent to "cycles per second." Higher frequencies are experienced as higher pitch.
[10] Steve Goodman, *Sonic Warfare: Sound, Affect, and the Ecology of Fear* (Cambridge, MA: MIT Press, 2010), 18.

just the right tempo and volume to encourage movement through the space and muffle a shopper's inner monologue, or to discourage their presence.[11]

Hidden behind a grille in a store's ceiling, a few tiny holes in a cell phone, or a scrim of fabric in a home stereo system, the typical loudspeaker resides in an enclosure. The speaker itself is invisible even when it is activated. Its placement may maximize acoustic reach, often superseding other aesthetic or functional interior design considerations, but its inert cabinet rarely harmonizes with the room around it. Even when we notice the speaker's enclosure, we tend to ignore its physical presence. On the other hand, when a speaker's cone is displayed in plain view, it is mostly for pure spectacle: you are about to rock.[12] Even then, we see only its front: a circular void, moving back and forth almost imperceptibly.

A speaker as a sonic object is especially valued for its discretion. The best speakers have a "flat response," meaning that they accurately reproduce a signal across the frequency spectrum. Audio engineers use terms like "transparent" to describe the production process of content created for speakers. Even for listeners who prize the "warmth" imparted by particular equipment like a vacuum tube amplifier or vinyl record

[11] In recent decades, loud classical music is commonly piped outside storefronts to disperse loiterers, carrying with it an implicit class aggression.

[12] The academic electroacoustic music tradition that grew out of *musique concrète* fetishizes the presence of speakers in large quantities. For example, the Birmingham ElectroAcoustic Sound Theatre (BEAST) at the University of Birmingham consists of more than 100 loudspeakers of various sizes distributed around the room through which performers "diffuse" compositions for a listening audience. However, speakers are referred to as "channels," their qualities as objects discounted or masked as the audience listens to music in the dark.

player, the speaker's peculiarities are only ever a curiosity or detriment. [13] As with many tools of control, the speaker can be most effective when it is invisible.[14]

Evocative Things

Media theorist Sherry Turkle coined the phrase "evocative object" in her book *The Second Self* to describe something that promotes self-reflection and emotional attachment.[15] An evocative object generates thought and ideas through its use; for example, a computer (in Turkle's original example), a cello, or a trusty journal. Crucially, there is a feedback loop between the use of the object and its ability to generate thought. A person improves at playing an instrument through continued use, but also grows in their ability to express themselves through the object. An object also can become evocative through a sentimental connection to the user that exceeds or ignores its functionality, but nevertheless reinforces attachment through use.

Despite their ability to convey information and expression through sound, speakers are a kind of *anti*-evocative object. While contemporary material culture showcases speaker-filled objects that approach the evocative — the cassette boombox, for example, or its successor, the portable Bluetooth personal sound system — the

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[13] In contrast, a lower-quality or specialty-design speaker may boost or attenuate signals at certain frequencies, giving the listener a distorted rendering of the signal being sent through it. The "warmth" valued by certain audiophiles is actually characteristic distortion created by the electronic components in the circuit.

[14] Of course, the very visible threat of a sonic weapon for riot control precludes it needing to make any sound at all. However, authority can be woven into the invisible speakerscape without material presence. The Muzak corporation has become synonymous with designing unobtrusive equipment and content for commercial retail spaces. Jacques Attali notes that Muzak "[presented] itself as the 'security system of the 1970s' because it permits use of musical distribution channels for the circulation of orders. The monologue of standardized, stereotyped music accompanies and hems in a daily life in which in reality no one has the right to speak any more." Jacques Attali, *Noise: The Political Economy of Music,* trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1985), 9.

[15] Sherry Turkle, *The Second Self: Computers and the Human Spirit,* 20th Anniversary Edition (Cambridge, MA: MIT Press, 2006), 2.

mechanism of the speaker itself is concealed as much as possible. What the personal sound system projects is its owner's cultural identity in public or private space through its sonic content. When the device is switched off, it becomes dead weight. A speaker's evocation begins when it sounds and ends when it falls silent.

Can the speaker itself become evocative? Critical theorist Bill Brown describes a different way in which our relationships to objects can be changed, by interrupting their functionality and turning them into "things." For example, the window we look *through* becomes something we look *at* once it is broken.[16] The "thinged" material creates an uncanny inversion of subjective viewer and objective reality. The constituent parts working in harmony to create a useful object are suddenly exploded in a thing, rendered both excessive and lacking.

In *reciprocation*, I expose the materiality of speakers, showing their naked construction, hanging them so that they can freely move, and connecting them together using various materials. However, each of the many speakers used in *reciprocation* is identical, highlighting their different treatments and placements rather than their own inherent peculiarities. Discarding their acoustic abilities, the speakers become powerful symbolic tools to consider the imprint of audio technology on our society, as well as the human interpersonal relationships these now-evocative things can signify. We reciprocate back and forth from an equilibrium, we move in and out of phase with each other, and we transmit and receive energy, making and warping meaning along the way.

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[16] "We begin to confront the thingness of objects when they stop working for us: when the drill breaks, when the car stalls, when the windows get filthy, when their flow within the circuits of production and distribution, consumption and exhibition, has been arrested, however momentarily." Bill Brown, "Thing Theory," *Critical Inquiry,* Vol. 28, No. 1, Things (Autumn 2001): 4.

fate

One of the pieces in *reciprocation*, titled *fate*, subverts the normal function of speakers and also positions them in an unfamiliar way. The sculpture consists of two identical speakers, one resting on the floor, its cone facing upward, and one hanging high above it, its cone facing downward. Dozens of thin red cords are tightly strung in parallel between the centers of each speaker cone, connecting in concentric circles that recall the grille pattern on a telephone earpiece. The speakers undulate in equal but opposite directions like distant lovers, pushing and pulling the thread.[17] The red threads slap against each other in a constant whisper as they oscillate individually, driven by the inaudible speakers they span.[18] The movement increases and decreases as the subaudio oscillator driving the speakers speeds up and slow down, but both speakers always move in opposite directions and with equal amplitude.

[17] The title of the work is a reference to the East Asian belief that lovers destined to be together are connected by a "red thread of fate." However, red thread is a significant motif in many cultures. For example, the *kautuka* worn around the wrist by Hindus signifies a bond between spouses, and the crimson string wards off the "evil eye" in some Jewish practices.

[18] When the speakers are not moving, the threads are parallel, but the curved geometry of their attachment points and subtle variations in length cause them to collide when the speaker moves.

Figure 4. *fate* (detail).

Figure 5. *fate,* installation view (rendering).

Listening Through Other Senses

In contrast to the loudspeaker, the human auditory system is almost comically byzantine. Traveling down the ear canal, a sound wave causes the eardrum to vibrate.[19] The eardrum pushes against the three tiniest bones in the human body which connect in series, displaced ever so slightly so that they agitate fluid within the cochlea, a spiral-shaped chamber in the inner ear. Tiny hairs in the cochlea bend against another membrane and transmit electrical signals to the brain as they flex. Evolution's gradual accumulation and shaping over millions of years created a complicated system full of specialized parts, each subject to its own organic variation.

The inner ear also contains the sensory organs of our vestibular system, the system that literally grounds us, constantly giving us spatial orientation. The three semicircular canals attached to the cochlea contain fluid that shifts as we tilt our heads, sending information to our nerves as fluid moves in opposition to head movement and gravity. That sound is intimately connected to our sense of balance and bodily awareness is no accident. Both rely on reciprocation: the energetic movement of matter transmitting sound, the sensing instrument sympathetically resonating. Like a speaker, there is a "push-pull" system that operates through deviation from equilibrium. When our head moves one way, the sensing canals of the other directions are inhibited, the fluid inside moving in the direction opposite to our movement.[20]

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[19] If the eardrum worked like a microphone's diaphragm, the pressure would cause an electromagnet to move back and forth, creating changes in voltage: a speaker exactly reversed.

[20] Timothy C. Hain, "Neurophysiology of Vestibular Compensation," dizziness-and-balance.com (Chicago Dizziness and Hearing, January 30, 2019), https://www.dizziness-and-balance.com/anatomy/physiology/compensation.htm.

What can we make of the fact that sound shares an anatomical connection with our spatial orientation? Critically, our perception of sound is indeed spatial, helping us to determine the makeup of the world around us. Hearing a combination of "direct" sound (sound traveling unimpeded from its source to our ears) and "reflected" sound (sound scattered by surfaces in the environment) gives us information about the size, material, and density of our surroundings. [21] But for many of us in daily life, this sonic awareness does not rise to a level of primacy in sensing our environment, as we focus on the content of the direct sound reaching us while using our sight and touch to assess the world.

The connection of our auditory system with the vestibular system may be more an anatomical convenience than anything else, but sound's prime connection with the tangible and tactile world is intuitive to people across a wide range of hearing abilities.

Approaching cultural history through sound necessarily sets a divide between hearing and seeing, but it also does so between the hearing and the not hearing.[22] At the same time, those who do not hear experience the physicality of sound through bodily means beyond the ear. Many deaf people feel low frequency vibrations, gaining pleasure from music that activates the tactile. A common practice for hard-of-hearing concertgoers is to hold an inflated balloon, which tingles in response to the music in a manner analogous to the eardrum. Other deaf people with cochlear implants, which directly stimulate the auditory nerve with electricity, can also sense electrical fields and ultrasonic interference. These extra-aural ways of experiencing sound not only upend the

[21] Acoustical engineers understand that an ideal listening space – one free of distortions from the sound interacting with the room itself – is impossible, so they design spaces which aim to scatter and diffuse direct sources in a manner that reinforces rather than obscures direct sound to heighten its intelligibility.
[22] Michele Friedner and Stefan Helmreich, "Sound Studies Meets Deaf Studies," *Senses & Society* 7, no.1 (2012): 73.

hearing/non-hearing dichotomy, but they also underscore the simplicity and ubiquity of sound as a process. Sound fully envelops the body beyond the ear and is continuously propagating through the stuff of the world around us.

harmonic curtain

Viewers are confronted with the tactile nature of sound when encountering *harmonic curtain*, installed above the entrance to the exhibition. A row of speakers spans across a wide curtain rod, thick jack chains dangling vertically from their centers. Several other, thinner chains connect these vertical descenders in low arcs between each speaker.[23] The overall shape created by the series of hanging chains recalls the decorative fabric bunting of ornate drapery, rendered as a transparent and vibrating line drawing.

The chain arcs that block most of the entrance to the exhibition encourage viewers to implicate their bodies in the messy, unrestrainable motion of the connected sounding systems. Is the subtle motion of the curtain caused by the speaker directly above it, by another speaker connected to the arcing chains, by the visitors' own bodies, or a previous visitor's movement through the entrance? All of the above are possible, but the chains make their most distinct audible sounds when a body disturbs them, causing them to collide with each other.[24]

The entire form of the work is derived from the harmonic series, the naturally occurring relationship of resonating bodies that our ears interpret as consonance in

[23] Technically, each arc is a "catenary," the shape made by a chain suspended from two fixed points.
[24] The work pays homage to Felix Gonzales-Torres' series of beaded curtain works, which also are activated by the interaction of bodies.

music.[25] The horizontal spacing of the speakers along their rod, the lengths of each chain, and the frequencies that pass through them are all derived from harmonic ratios. The hour-long composition of subaudio frequencies, which activate the chains' movement, is divided into sections of harmonically-related duration, and each frequency (and therefore wavelength) of each sine wave passing through them is derived from a harmonic relationship to the length of the chains.[26] Rather than *hearing* harmonic relationships, as in music, the viewer-listener experiences this pervasive and fundamental sonic principle through sight and touch. The work illustrates the connections between sound and matter, highlighting the complicated interactions of even simple vibrating systems and the fundamental interconnections among length, frequency, and duration.

[25] The harmonic series is a mathematical construct, an infinite sequence formed by adding the reciprocals of whole numbers ($\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}\ldots$). Every object vibrating at its lowest, fundamental frequency also contains "harmonic overtones" that are frequencies multiplied by these simple whole number ratios. Musical tuning systems across cultures are based on harmonic ratios to some degree – our musical taste is directly informed by the anatomical phenomenon of hearing that transcends cultures.

[26] See Appendix A: *harmonic curtain* Description and Score

Figure 6. *harmonic curtain,* studio installation panorama.

Figure 7. *harmonic curtain,* detail.

The Speaker and the Body

Despite their differing materials, the speaker and the body (especially the ear) work from the same reciprocal movement. Sound is created as a result of the displacement of matter from the thin membrane of the speaker's cone, and this displacement is directly mirrored in the flexing of the eardrum.

The borders of a body and a speaker belie their interface with the world. Rather than discrete entities with fleshy or machined edges, the body and the speaker become interfaces for the self, emanating beyond their notional boundaries. The "sound body," writes performance studies scholar Deborah Kapchan, "inhabits but does not appropriate. It sounds and resounds but cannot be captured."[27] Our normal modes of interacting with the speaker object, and with other humans, discount the physicality of the projector and embrace the abstraction of the language they transmit.[28] The permeability of the sensing body and the pervasiveness of sound provide a seamless transition from the phenomenal to the affective, subsuming our perception of their literal physicality.

And yet, both the body and speaker limit expression. The movement of a speaker represents the continuous summation of internal forces, converting multiple signals into a single movement along a one-dimensional axis: in and out. Despite its numerous and subtle valences, the self as projected through the human body is bottlenecked by the limitations of speech, language, and social protocol.

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[27] Deborah Kapchan, "body," in *Keywords in Sound*, ed. David Novak and Matt Sakakeeny (Durham and London: Duke University Press, 2015), 39.

[28] Even in reading and transmitting body language cues, we make meaning out of the body as a whole, rather than focusing on its specific modulations that communicate tone or affect.

allegory

In *allegory*, the speakers stand in for bodies themselves. Eight speakers are suspended a few inches in front of a wall, facing toward it at slightly different angles. Each is supported by steel wires, stretched to the adjoining walls in a random web of intersecting, taut lines. At the same time, dangling electrical wires trail from each speaker to a monolithic, glossy black enclosure on the floor that contains the electronics driving them.

Figure 8. *allegory,* installation view (rendering).

Each precariously suspended speaker pulses at high amplitude, causing them to thump against their supports, their wire, and the wall. Each speaker also projects a halo of light onto the walls from LEDs hidden in its cone, expanding and contracting as the cone moves in and out.

As an inversion of Plato's "Allegory of the Cave," the tethered bodies in this work are not prohibited from perceiving the shadows of objects cast on the wall in front

of them; rather, the viewer-listener is only able to perceive the light and sound motion of these captive speaker-bodies indirectly. The extremely low frequencies that pulse through each speaker would be inaudible without the implication of their surrounding restraints. They resemble irregular heartbeats, casting the dangling speaker and light wires as an uncanny life support system. The piece contains several distinct episodes of different colors and rhythms that move throughout the "ensemble," punctuated by stretches of silence and darkness.[29]

[29] The "composition" of this piece was created through mapping each speaker to a keyboard key, and recording improvisations with this novel "instrument." The reciprocal relationship of building an instrument while learning how to play it is often a working process in electronic music.

Phase Relations

Our ears are extremely sensitive to the frequency and amplitude of sounds we hear. However, we don't readily perceive "phase," the relative amplitude of a periodic waveform within a period of its cycle.

Like other aural phenomena, phase is perceived only as a matter of relations. A difference in phase is noticeable when two sound waves are combined together. If the sound waves are moving in the same direction, their magnitudes add in constructive interference, increasing the overall amplitude. When they move in opposite directions, they cancel each other in destructive interference. Theoretically, waves with identical amplitude and frequency that are perfectly out of phase with each other will sum to zero: one speaker pushes with the same intensity as the other is pulling, and vice versa. In practice, phase addition and cancellation are happening constantly as complex waveforms emanate from multiple speakers and interact with the room. In fact, even from a single speaker, every sound can be broken down into a combination of different sine waves, each simply described by its frequency, amplitude, and phase. It is the addition and subtraction of all these factors in a kind of energetic balance sheet, a single complex wave, that travels to our ear. Through the interaction of many smaller parts, each individual oscillation elides into a single movement, the sum of countless invisible relations.

Our understanding of sound is most stable when posed in dualities. We have two ears from which we can apprehend sound in three-dimensional space. Sound is created by vibration of a medium back and forth along a single axis, compressing and rarefacting

waves of energy away from an equilibrium. Phase differences among multiple waves resolve into a single position, a positive or negative sum.

In interpersonal communication, we also set up a system of two: the self, and the other. We push and pull, cancelling and adding our understandings of ourselves and each other in a constant negotiation of our cognition, language, memories, and bodies. While our identities and understandings of one another are the sum of many senses and contexts, they propagate along a single shared thread. However, our relationships — like sound in space — bleed. The additions and cancellations through which we make meaning emanate out to surrounding pairs of sounding bodies, influencing or overpowering them in a dance of constructive and destructive interference.

trine

trine complicates the normal stereo-speaker setup. Three speakers sit on the points of an equilateral triangle, facing each other and suspended inches above the floor. Strung between them is a mesh of thin silver chains, comprising interlocking triangles connected by copper-colored nodes. The audio playing through the speakers is from a recording of three intimate partners talking about their relationship with one another, rendered unrecognizable by converting each person's speech into very low frequencies that carry the cadence of conversation. The mesh ripples up and down, waves traveling across its shimmering surface.

Perfectly opposite phase is impossible among three speakers; one will always be moving in the same direction as at least one other. True reciprocal movement cannot ever be realized with these three individuals. Each speaker connects to the other along the side of the triangle in chained partnerships, and across the fabric of the polyamorous union.

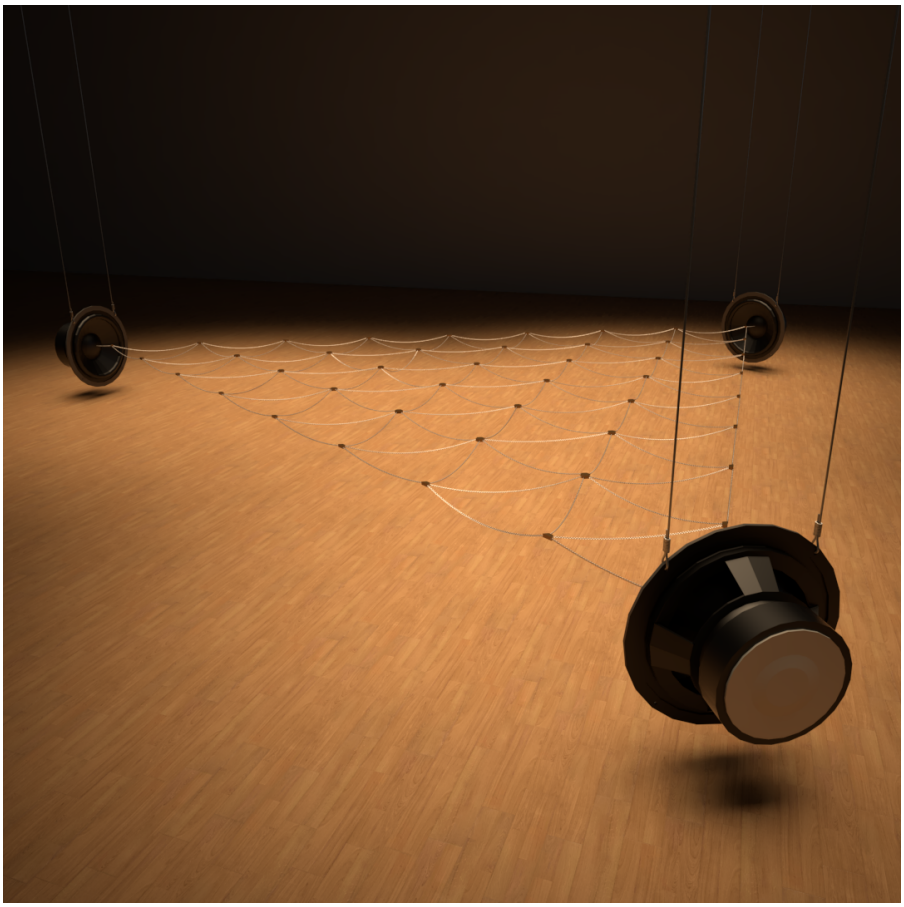


Figure 9. *trine,* installation view (rendering).

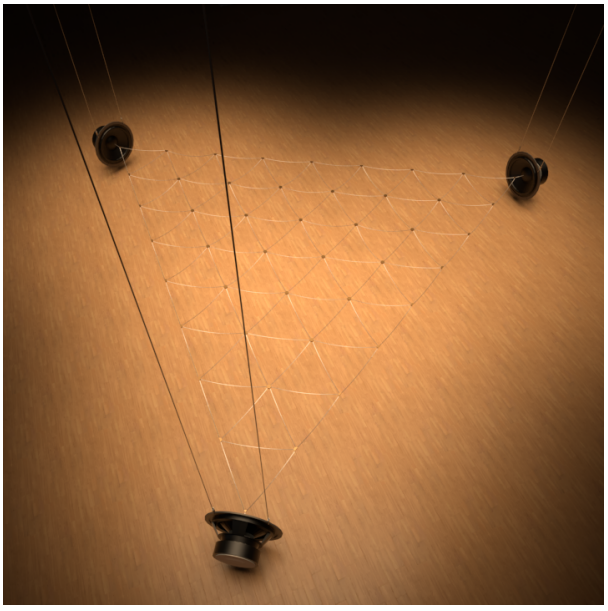


Figure 10. *trine,* detail (rendering).

Erotic Materials

The speakers in *reciprocation* are broadly austere and utilitarian in their black and silver metal and paper and are also uniform in their size and shape. The hardware that suspends them – steel wire, chains, eye hooks, and speaker wire – comprises the bland connective tissue that usually disappears into the manufactured world around us, like the everyday speakers that rarely draw attention to their material presence. While the works in *reciprocation* describe a broader negotiation of the self with others — both the ego and the body — it is the materials they animate that actually make sound and illustrate the dynamics of human relationships.

The focus on speakers as "evocative things" casts them as fetishes, "objects endowed with qualities pertaining to human relationships."[30] In contemporary colloquial use, "fetish" takes on a sexual connotation, particularly in reference to sadomasochism subcultures. Chains and wire, metal O-rings, and glossy black paint suggest bondage fashion; indeed, each of the works focuses on restraint and power in different, subtly gendered ways. For example, the network of thick jack chains in *harmonic curtain* is hung in arcs reminiscent of fetish wear, while the chains in *trine* are delicate and shiny, suggesting fine jewelry. The macramé threads connecting the speakers in *fate* evoke domestic crafts or even religious objects like knotted Catholic rosaries or Jewish *tzitzit*.[31] The contrast between the rigid support wires and the organic, flowing electrical wires that connect to the speakers in *allegory* highlight the tension between bodies in motion and rigid technologies of control.

[30] Alfonso M. Iacono, *The History and Theory of Fetishism* (Hampshire: Palgrave Macmillan, 2016), 1.
[31] The knotted tassels worn by observant Jews.

The physical placement of speakers also suggests different power dynamics. In *fate*, the perfectly reciprocal movement of each speaker cone may at times be obscured by the suspended position of one over the other, casting them as a dominant and submissive pair; in *trine,* the inward-facing speakers hanging at equal height suggest an equitable relationship.

Superposition of Silence

An always present *I* is constituted only by confrontation with an always absent *you*.
– Roland Barthes, *A Lover's Discourse: Fragments*[32]

Sound is a phenomenon of relations, existing only with dynamic change in its vibrating media, born into a purely phenomenological experience in the body. And yet, its negation — silence — is impossible, simply as the consequence of *having* a body.[33] Silence, then, is more than the absence of sound. It is created in negative space by the sound around it, when potential energy materializes into the aural. An emergency siren flares out from the top of the pole, ready to spin into shrill warning. A glass vase teeters on a ledge above a concrete floor, waiting for gravity to shatter its brittle body. One waits for the pregnant pause in a conversation to resolve into agreement or confrontation. Silence is profound to the non-cochlear experience of sound, not least because it requires a viewer-listener to imagine its conversion from potential to kinetic energy. Silence is this potential energy. Once silence is breached with sound, its myriad sonic possibilities collapse into a single manifestation. The speaker sits at rest, able to project any sound from an infinite collection of unrealized sonic energy.

Silence extends from the aural to the lingual. On the telephone, silence creates a superposition of attention: I must repeat myself when I mistake my interlocutor's

[32] Roland Barthes, *A Lover's Discourse: Fragments*, trans. Richard Howard (New York: Hill and Wang, 1978), 14.

[33] John Cage famously relayed that he discovered that silence was impossible in an anechoic chamber at Harvard University. "In that silent room, I heard two sounds, one high and one low. Afterward I asked the engineer in charge why, if the room was so silent, I had heard two sounds…he said 'The high one was your nervous system in operation. The low one was your blood in circulation.'" While these specific attributions have been called into question, it is impossible to escape the sound of one's own breathing, tinnitus, and sometimes heartbeat. John Cage and David Tudor, "John Cage and David Tudor Reading Music," *Indeterminacy* (Washington, D.C.: Smithsonian Folkways Recordings, 1992), SFW40804, CD.

preoccupation with something on their end of the line for their rapt attention to our conversation, or the cell signal has been lost and I am speaking to no one. Furthermore, the dull ring I hear in the handset communicates nothing about why the other party is not picking up: did they see my name appear on the screen and decide not to answer, or did they not hear it ring? I speak into the void until I hear something other than silence reflected back.

Roland Barthes wrote about communication through sound (via the telephone) and the agony of silence, in his 1978 book *A Lover's Discourse: Fragments*:

> On the telephone the other is always in a situation of departure; the other departs twice over, by voice and by silence: whose turn is it to speak? We fall silent in unison: crowding of two voids…what does this gift mean? Leave me alone? Take care of me? No one answers, for what is given is precisely *what does not answer*.[34]

For Barthes, the ambiguity of silence is as fraught as any other part of spoken language. Barthes also addresses silence as the vehicle for the remembered sound, the yearning of the non-cochlear, the sense memory:

> What constitutes the voice is what, within it, lacerates me by dint of having to die, as if it were at once and never could be anything but a memory…. I never know the loved being's voice except when it is dead, remembered, recalled inside my head, way past the ear…it is one of those objects which exist only once they have disappeared.[35]

Composing Silence

Silence is an important part of the works as a whole in *reciprocation*. Sound art is notoriously difficult to program in a gallery space, as it does not stay neatly restricted to its frame on screen or canvas. The number of large speakers throughout the works seem

[34] Barthes, 116.
[35] Ibid., 114.

disproportionate to the actual sonic result: each speaker only pulses at subaudio frequencies, too slowly to actuate the air molecules around them into audible sound. However, they do make sound because of the solid materials with which they interact.

Each piece in *reciprocation* has silence (or more precisely, inactivity) built into the audio compositions that drive them. This negative space in time is to allow "breathing room" for the sound they create in the space they share, but also to highlight moments of coincidence that might arise among their unsynchronized durations.

When each speaker is at rest, it once again becomes an object charged with latent potential: not just silence, but also desire. "In order to show you where your desire is, it is enough to forbid it to you *a little*, " Barthes continued in *A Lover's Discourse: Fragments*, "while leaving [you] free *a little*: flexible, going away occasionally, but *not far*: on the one hand, I must be present as a prohibition…but also I must go away the moment when, this desire having formed, I might be in its way."[36]

Sound is dynamic change, starting at its source and echoed through matter in the environment and in the body. But silence is its resonant absence, dynamic change in the domain of memory.

[36] Ibid., 137.

Appendix A: *harmonic curtain* description

Description

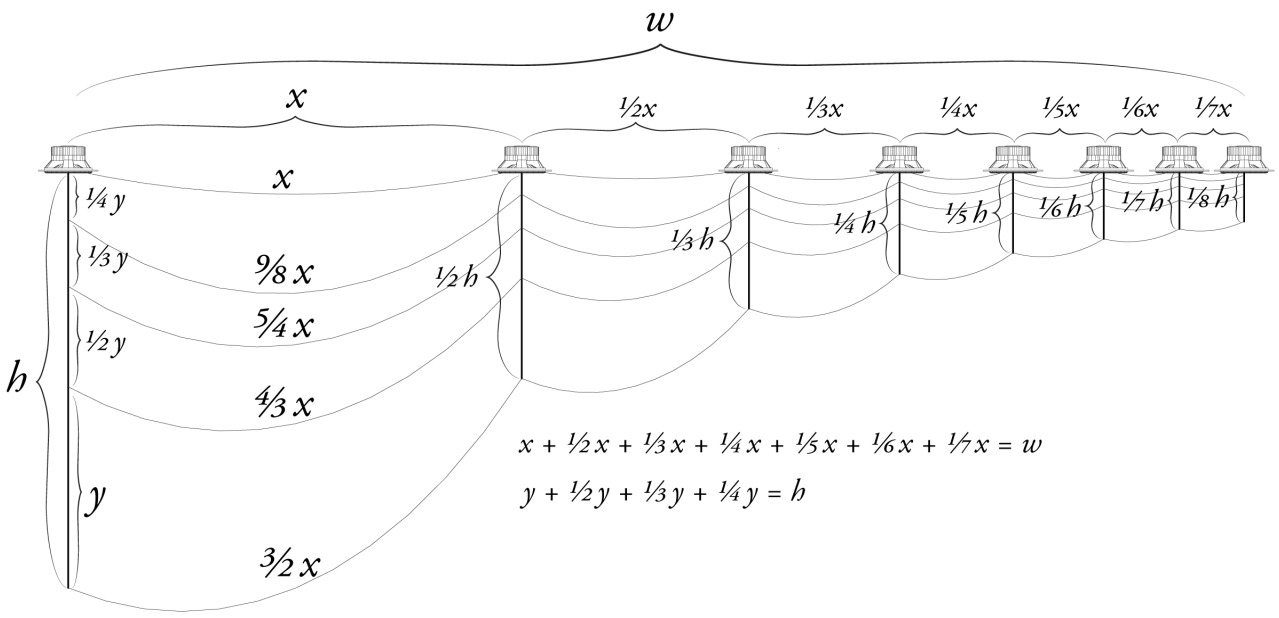


Figure 11. *harmonic curtain* plans.

harmonic curtain is divided horizontally into seven segments, with one speaker at the beginning and one at the end of the span. Speakers are placed at harmonic partial distances along this width (*w*).

Each speaker has a vertical descending chain attached to the center of its cone. The length of each descending chain is a harmonic partial of the first chain's length (*h*). Each of the descending chains is divided into its own series (with four partials), with the catenary chains attaching at these partials.

The catenaries spanning the vertical descending chains have lengths determined by the corresponding partial of the series based on (*x*). However, rather than the simple reciprocal relationships (1/*n*) of the harmonic series, their lengths are related to other whole-number ratios that serve as the basis for most musical tuning systems. These proportions derived from whole-number ratios ($\frac{1}{1}, \frac{9}{8}, \frac{5}{4}, \frac{4}{3}, \frac{3}{2}$) are the "pure" first five notes of a major scale.

In the planned exhibition version of this piece, *w* = 14 feet, *h* = 5 feet.

Composition

harmonic curtain's sixty-minute loop is divided into nine sections of harmonically related durations. Each section is itself divided into subsections which specify different combinations of active speakers, each driven by an amplitude-modulated sine wave oscillator.

The possible frequencies for each oscillator are derived from the physical length of the chains in the installation. This version was created with the specific dimensions of the exhibition in mind (*w = 14', h = 5'*), trying to remain in sub-audio frequencies for most of the loop.[37]

The fundamental frequency of each speaker's oscillator — at which one period of the cycle is equal to the length of the chain — is related to the length of its vertical descender chain:

fundamental frequency (Hz) = speed of sound* / length of chain

*for simplicity, the speed of sound used was that of dry air at 20° C, 343 m/s.

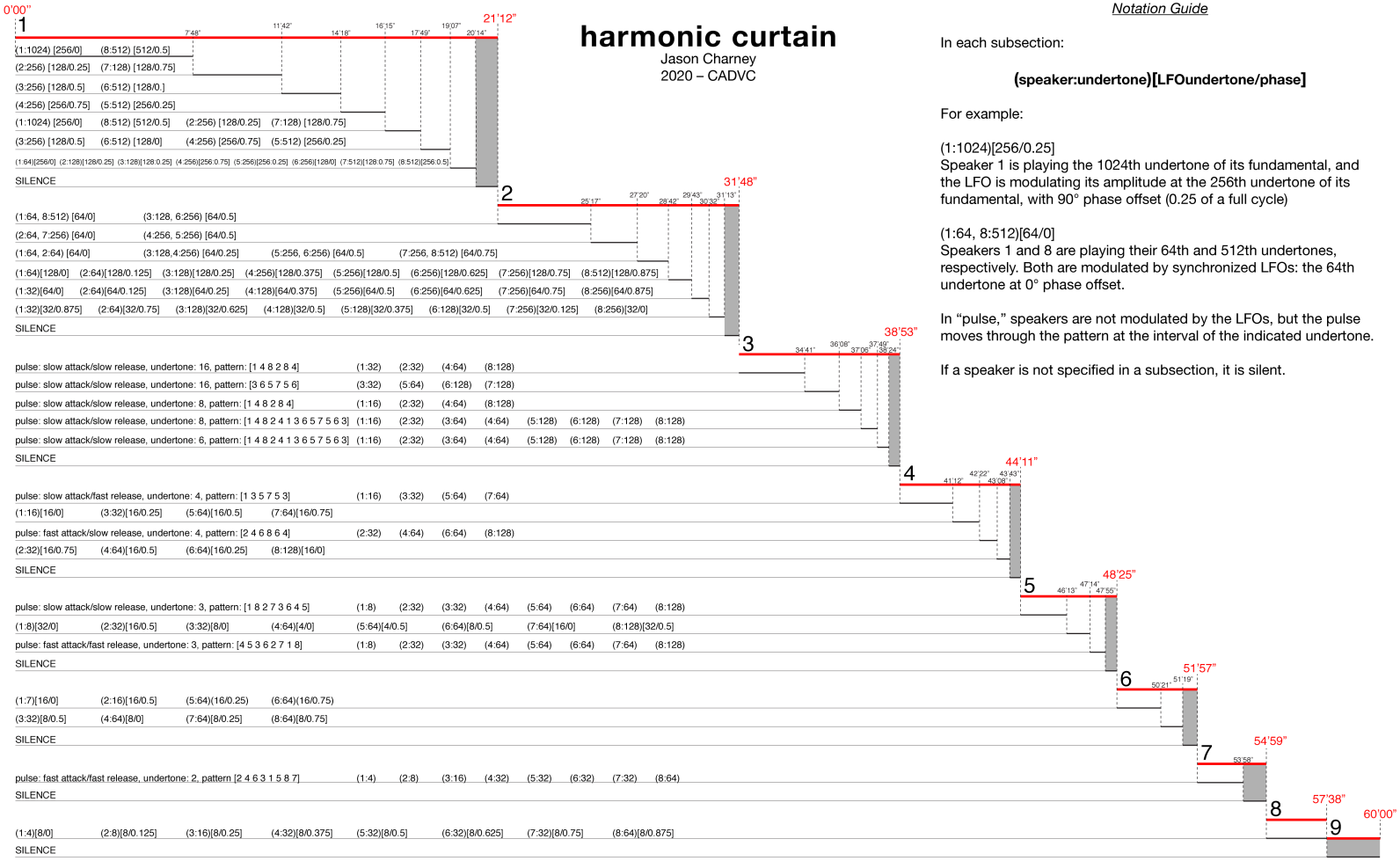
The frequency of each chain's oscillator is a whole-number reciprocal of its fundamental, an "undertone" (e.g. the 64th undertone of 440 Hz = 1/64 * 440 Hz = 6.875 Hz). These undertones change over the course of the piece, speeding up or slowing down but always in harmonic relationship to the chain they animate.

Likewise, each speaker's amplitude may be modulated by its own phase-offset low-frequency oscillator (LFO). Each has undertones based on the same fundamental frequency, derived from the sum of the lengths of all chains used: vertical descenders AND catenaries. This allows coordinated modulation (e.g. the same frequency at phase offsets) while retaining a connection to the physical system of chains.

Alternatively, oscillator amplitude may be modulated by short linear envelopes moving across the speakers in various patterns. These sections are designated as "pulse" in the score. The interval of pulses is also a variable undertone of the same fundamental frequency of the LFO.

The score may be displayed with the installation to illustrate the harmonic relationships of duration as well as space.

[37] Also, distributing the load around the speakers such that they wouldn't overload the amplifier shared by adjacent pairs. Which reminds me: the amplifiers should be as loud as possible without jeopardizing the integrity of the installation: dislodging chain attachments to the cone, dangerous movement of the speakers or their hanging supports, or injuring viewers.



Notation Guide

In each subsection:

(speaker:undertone)[LFOundertone/phase]

For example:

(1:1024)[256/0.25]
Speaker 1 is playing the 1024th undertone of its fundamental, and the LFO is modulating its amplitude at the 256th undertone of its fundamental, with 90° phase offset (0.25 of a full cycle)

(1:64, 8:512)[64/0]
Speakers 1 and 8 are playing their 64th and 512th undertones, respectively. Both are modulated by synchronized LFOs: the 64th undertone at 0° phase offset.

In "pulse," speakers are not modulated by the LFOs, but the pulse moves through the pattern at the interval of the indicated undertone.

If a speaker is not specified in a subsection, it is silent.

Figure 12. *harmonic curtain* display score (11" x 17").

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