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Radio at its most basic is the perception of frequencies in the electromagnetic spectrum between 3Hz and 3000MHz, or below visible light. In our current configuration, terrestrial radio is characterized by wireless transmission in the service of point-to-point communications: a process of modulating electromagnetic radiation which occurs by changing the amplitude or frequency of the radio waves from a point (the transmitter). The modulated waves carry information to another point via transduction and transmission: for instance, sound waves are transduced from human mouths through microphones into signals, which radiate from a transmitter antenna, travel through space, are detected by receiver antennas, and are in turn transduced by vacuum tubes or transistors and speakers into sound waves audible to the human ear. When the term 'radio' is invoked, people commonly think of either a radio receiver apparatus, the

activity of broadcasting from a radio station, the programming, the branded name of a radio station, or a location (channel) on the AM/FM radio dial. The conflation of electromagnetic activity with one-to-many steady-state audio broadcasting or with radio sets for tuning in at home reveals the degree to which the current configuration of radio has been naturalized, and to which radio has been fixed in the popular imagination by a century of state and commercial imperatives. Furthermore, the oft-repeated popular myths of radio's modern origins, however fabled, contribute not only to linear notions of technological progress, but also serve to ideologically fix what can only be historically, economically, and culturally contingent applications of radio waves.[1]

Despite the dominance of the one-to-many broadcast paradigm, over the years radio has been remixed and repurposed, stolen outright,[2] left for dead[3] and resurrected.[4] What other possibilities might exist for radio in the popular imagination, what significance might radio have outside of the practice of modulating waves by a carrier signal? Artists and tinkerers have been prying radio out of the black box for some extended play, and continue to explore radio in terms of its radiophonic phenomena. Here I refer not to practices of sampling, subverting, or transforming broadcast content or formats, but to experiments of playing the waves themselves, which are not, in the end, ethereal, but very much of this world: material, palpable, and affective. Such practices of radio play propose entry points into realms that surround us daily but elude our unassisted perceptions: the otherwise inaudible radiophonic landscapes described by the activities of electro-magnetic waves.

This paper considers the relations of proximity, distance, interference, and feedback invoked by casting radio as instrument. I am interested in the potential for the notions

'radio' and 'instrument' to mutually reinforce or subvert one another in such a meeting. Radio as instrument involves a circuit of devices and bodies, near and far; where sound serves as an index of these relationships, and begins to shift radio away from the paradigm of radiation (from the Latin *radiare*, to emit rays) and towards oscillation and resonance (to resound). Beginning with the theremin, an early twentieth century electronic instrument with which sound is created through the interaction of two radio frequency oscillators and the human body, I go on to consider contemporary radio practices that employ low- and micro-watt transmitters, receivers, and bodies to create sonic installation and performance works characterized by dynamic radiophonic feedback.

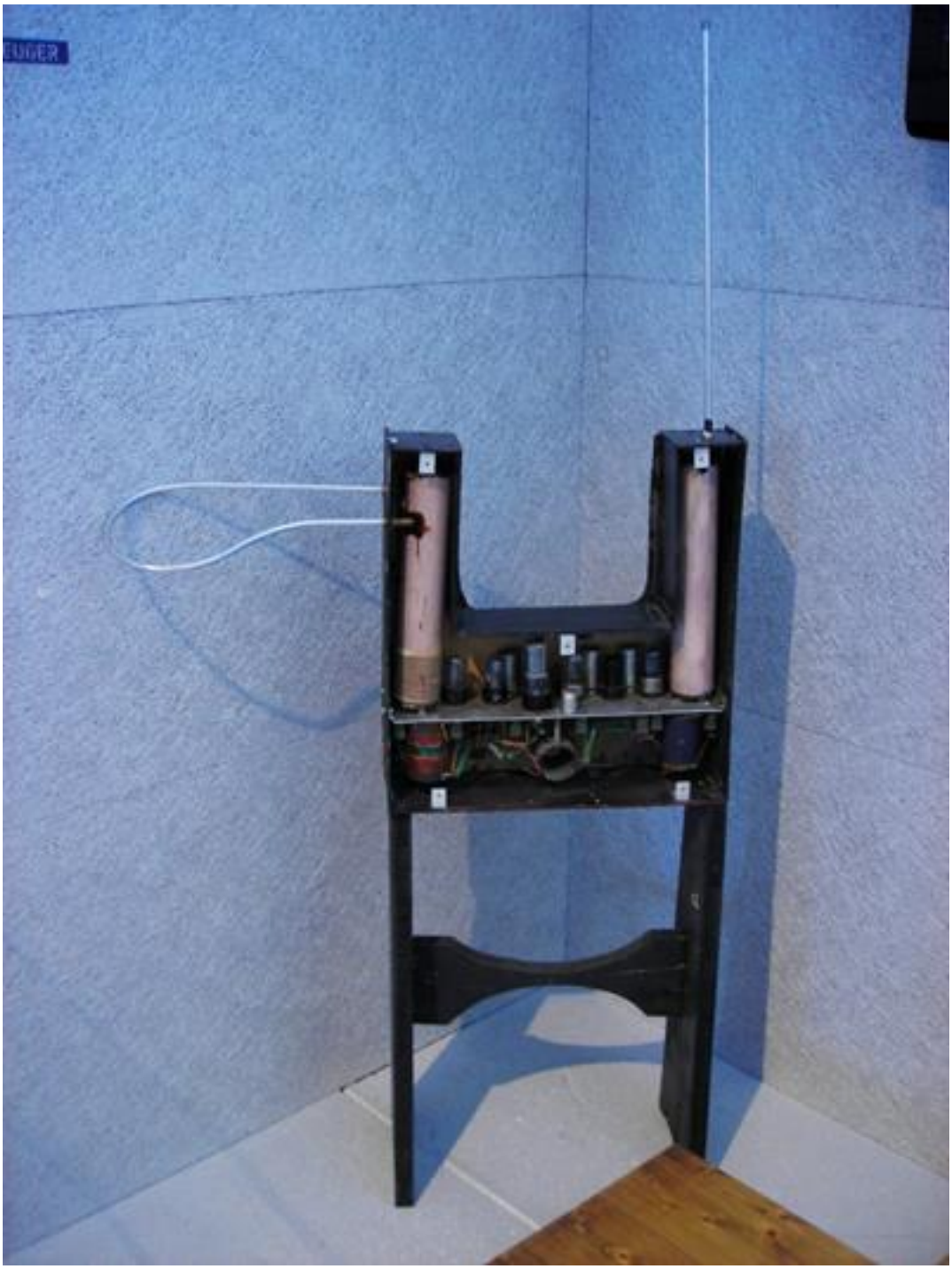
The theremin is one of the earliest electronic musical instruments, and is popularly named after its inventor Lev Sergeyevich Termen, whose name was westernized to Léon Theremin. Born in 1896 in St. Petersburg, as a young man he studied cello, astronomy, and physics. During World War I, he began working with radio in a military engineering school, and later, as an officer of military radio engineering, he oversaw construction of state-of-the-art radio towers and taught in the Radio Technical department at the Graduate Electrotechnical School for Officers. After the war, he took a post at the Physico-Technical Institute in Petrograd, supervising a lab for experimenting with high-frequency oscillations, where he eventually set up his own lab to work with electromagnetic waves, and began focusing intensively on the possibilities suggested by new inventions from abroad such as audion tubes (early vacuum tubes) and regenerative feedback circuits.[5]

Theremin's early projects explored the potential of the human body as an electrical conductor–the body's ability to store up charges, or capacitance. In an electrical circuit, capacitance is regulated by a capacitor made up of two condensing plates, separated by a non-conductor which functions to accumulate electrical charge. A person standing near an electrical circuit will potentially effect the capacitance in that circuit, causing a change in the parameters of the circuit. Theremin's first application in this line of thinking was to build a kind of burglar alarm: he directed waves of a specific (inaudible) high frequency to an antenna via an oscillating audion (tube) that functioned as a radio transmitter. The antenna was a control conductor, radiating the waves in a limited magnetic field. He adjusted the circuit so that when a body entered the field and affected the capacitance of the circuit, this would trigger a contact switch to close, and an alarm would sound. He called this invention the "radio watchman". (Glinsky, 2000, p. 23)

Theremin then set about designing a similar circuit that would detect subtle gas fluctuations: the density of a particular gas would be represented by a single tone, and any change in the whistling pitch would be the result of changes in the properties of the gas. Again, he noticed that the human body's proximity effected the circuit, as moving his hand within the circuit caused shifts in tone, with the pitch fluctuating higher the closer his hand was to the capacitor. His experiments quickly made him famous in the lab, as many flocked to hear Theremin play melodies on a 'capacitometer', or what was designed as an instrument of scientific measurement. (Glinsky, p. 24)

These experiments set the stage for Theremin's development of a musical instrument: the etherphone, as he first called it, which became known as the thereminvox, and eventually simply the theremin. Natural body capacitance, this time just from the hand,

interfered with the electromagnetic field emanating from the device, introducing a change to the capacitance of its circuit and thus altering the oscillating frequency. To make the instrument more sensitive, Theremin applied the heterodyne principle, in which two high frequencies are combined to produce a lower-frequency third, whose frequency is the difference between the first two. For instance, a frequency of 21,000 cycles per second combined with a frequency of 18,000 cycles per second "beats together" to produce an audible frequency at 3,000 cycles per second. For his nascent instrument, Theremin used two very high frequency fixed oscillators that each produced the same note far beyond human hearing, with one remaining fixed while the other was variable. The variable oscillator was attached to a weak antenna sticking vertically out of the box in which the circuit was built. When a human hand moved closer to the antenna, the body's natural capacitance added more capacitance to the circuit, reducing the frequency of the variable oscillator to a pitch lower than the fixed one, so that the two frequencies 'beat together' to produce a pitch within the range of human hearing. Moving the hand to different distances from the antenna produced different beat frequencies: the closer the hand to the aerial, the higher the pitch; the further away, the lower the pitch, until the hand left the field of the circuit, returning the heterodyning function to the neutral status of zero (and as a result emitting no sound).



1961 theremin, built by Léon Theremin, photographed at the *Zauberhafte Klangmaschinen* Exhibition, Hainburg, Austria. October 2008. Photo: Anna Friz.

The electromagnetic field generated by the high frequency oscillators could detect extremely small capacitance changes, making possible a subtle control interface based on a changing field of proximity, rather than by touch. The sound of the instrument was characterized by glissando– a continuous slide up and down in pitch between notes. Theremin added a volume aerial (which functioned according to the same principle as the pitch aerial, but resulted in changes in volume of the note created with the pitch aerial) to give control on the attack of the note, which allowed individual notes to be played despite the glissando effect. The three-to-four octave touchless instrument was ready for its public debut in 1920 (Glinsky, p. 26).

The story of how the theremin gained popularity and eventually came to the West during Theremin's tenure in New York City from 1928 until his sudden return to the Soviet Union in 1938 is a fascinating tale in and of itself, and has been amply covered elsewhere.[6] However, I have detailed this obscure if captivating moment in the history of radio as I particularly want to emphasize the embodied nature of Theremin's inquiry into radio waves, and the curious mixture of innovation and conventionality that characterized Theremin's radio play, both of which have important implications for contemporary radio and transmission art practices. No doubt there were many early amateur radio enthusiasts who tweaked and tuned their rigs to produce the signature oscillations later associated with the theremin, and as a former radio operator, one can safely speculate that Theremin had also experienced such sounds before his work on the theremin. However, Theremin's training as a classical musician in general and cellist in particular contributed directly to his curiosity and interest in developing an electronic musical instrument from the observed incidental properties of what was meant as a scientific device.[7] Secondly, that training greatly influenced how Theremin subsequently built his instrument: his design choices for tone, pitch range, and style made the theremin an uncanny double for the violin or the human voice in chamber and orchestral music of the day. When Theremin toured the Soviet Union giving demonstrations of the instrument, he played pieces from his former cello repertoire such as Jules Massenet's *Elegy*. (Glinsky, p. 26) However, though Theremin worked to develop his new instrument within a particular set of historical, political, and cultural contexts that guided (and at times controlled) his technological investigations and design, the theremin proposed a radically different (and potentially popular) trajectory for still-new radio technology — one where transduced and transmitted sound did not

carry military information or public programming, but became an index of bodily and electronic relationships in space.

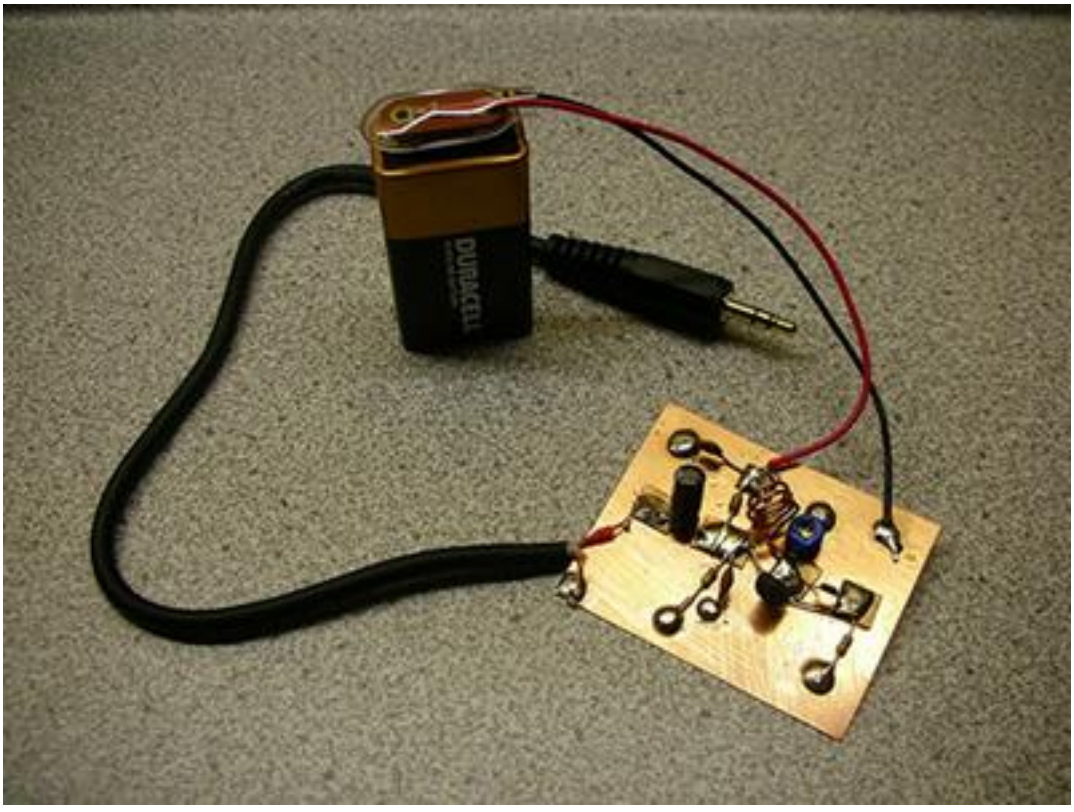
The theremin offers a very dramatic demonstration of the human and the technological as an ensemble rather than deterministic, dualistic, or prosthetic encounter–expressed in a circuit in which bodies are not erased but deeply implicated. Andrew Feenberg writes that "human beings can only act on a system to which they themselves belong. This is the practical consequence of being an embodied being. Every one of our interventions returns to us in some form as a feedback from our objects." (Feenberg, website) The theremin is a radiophonic instrument, but there is no terrestrial broadcast, no programming, no interplay of senders and receivers. Instead, radiophony is perceivable through a process of signal feedback and human expression, in an instrument that is realized in the embodied musical play of waves between vacuum tubes, antennae, and hands. However, it remains a challenge to play the instrument the way Theremin intended–in the virtuosic style of the concert violinist–so today the theremin is found mostly in popular and experimental music contexts, but rarely played in a classical music concert setting.[8]

Since the early twentieth century, artists and composers have engaged radio as transmission device, as apparatus for communication, as field of relationships, as landscape, as space of the imaginary, as utopos. Explorations of radio as a kind of musical instrument can generally be characterized by the playing or sampling of the content of a carrier signal, with examples ranging from oft-cited electro-acoustic compositions incorporating radio receivers to play back existing stations and interfrequency sounds, such as John Cage's *Imaginary Landscape No. 4* (1951) and

Jean Tinguely's *Radio Skulptures* (1962), to live samplings of broadcast media culture by artists such as Negativland, and People Like Us, to free103point9's *Radio 4×4* (2003-present).[9] Though the public could and did "play" the radio waves themselves (from amateur radio enthusiasts experimenting with their crystal radio sets to listeners carefully tracking a radio station across the dial in the era before frequency stabilizers, people were always able to experiment with the sounds of radio wave oscillation), the theremin and other radiophonic instruments like the Ondes Martenot were a minor path not widely followed in artistic explorations of radio. And despite its continued presence in contemporary popular and experimental music, the theremin is not popularly understood to be radiophonic at all. In fact, there are designs for 'theremins' which have nothing to do with radio technology or radio waves (such as 'optical theremins' which employ photo-transistors and respond to light), but which employ other key characteristics of the theremin, such as a touchless interface played by gesture, and the spooky glissando sine wave sound. However, some artists have maintained an interest in exploring and manipulating the electromagnetic waves themselves, including radio waves.[10]

Embodied communication and the reconsideration of distance and time through 'polymorphous' radio are central concepts for media theorist and performance artist Tetsuo Kogawa (Kogawa, 1994; Kogawa, 2005). He is perhaps best known for his part in the micro-radio boom in Japan in the 1980s, and for his micro-or mini-FM transmitter designs, that only transmit to a few city blocks at most. Inspired by pirate and free radio activities going on in Italy and England, Kogawa began building microtransmitters as a loophole in the highly restrictive state control of the radio dial. In practice, such small

transmitters might effectively re-materialize radio, as listeners and broadcasters are all in potentially close proximity to one another. Kogawa's radio transmitters were entirely demonstrable and comprehensible to users, who were able to build their own and hold 'radio parties' in the densely populated apartment blocks in Tokyo.[11] Polymorphous, in this sense, means different forms of transmission technology operating in the radio landscape at once, including those for independent and community expression. Importantly, Kogawa did not imagine linking these transmitters together to create one larger signal, nor did he propose any universal communion or experience from these experiments, but rather encouraged a re-appropriation of electronic technology for diverse, unscripted and idiosyncratic social use within a very formal society.



Though Kogawa takes some inspiration from the early twentieth century radio manifestos that call for artists' engagement with the sounds of the airwaves themselves,[12] he also resists the modernist notions of radio as disembodiment, or as a means of collapsing distance. More recently, Kogawa has turned his mini-FM transmitters to the task of artistic expression through embodied radio play. For his live performance piece *hand waving play with airwaves*, Kogawa utilizes up to six homemade 50-milliwatt FM transmitters tuned to the same or close frequencies to create sounds based entirely on multipath and harmonic interference–in other words, he employs simply the relative proximity of transmitters and receivers to one another, and the presence and gestures of his own body to generate highly dynamic if abstract sounds from 'dead air'. Rather than substituting technology for bodily function, Kogawa creates a circuit that includes diverse bodies, including his own and potentially those of the audience, such that the materiality of radiophony is made perceptible and palpable, particularly as the oscillating frequencies reach maximum sonic density in volume and frequency range. There are clear echoes back to the theremin in Kogawa's performative radio practice, however Kogawa asserts that his work did not stem from any engagement with the theremin, which he finds formally "too constrained".[13]

Tetsuo Kogawa, performing at 'Dom im Berg', Graz, Austria, October 7, 2007. Photo: Susanna Niedermayr.

Kogawa explains his choice of transmitter strength as reflective of a molecular politics and aesthetic: that is, identifying the minimum unit of diversity needed to create change. For Kogawa, the hands are the minimum unit of the body (Kogawa, 2008: 409), so, like the theremin, his circuit of transmission operates through feedback, and need only be large enough to be affected by the movement of the hands. Also like the theremin, though in a more frankly anarchic and noisy fashion, Kogawa's radiophonic circuit serves neither as an apparatus for communication nor for sharing out or broadcast of information, but instead expresses basic relations of proximity and distance, where distances are not overcome but differentiated. Unlike Theremin's focus

on extracting a classical musicality from his interaction with radio waves, for Kogawa the sound is secondary to his intentions. Like the theremin, the sound operates as an index of change in positions and relations within the circuit, and in Kogawa's performances sound manifests with enormous dynamic and spectral range, quite unlike the pure sine tones to be played melodically on an original theremin. Where Theremin chose to invoke the authority and grace of orchestral musical instruments by building his circuit into beautiful wooden lectern-shaped furniture and exploiting the showmanship of both the concert hall and the séance, Kogawa deliberately demystifies his practice by working with circuits that are entirely revealed outside of the black box: his transmitters are exposed electronics hand-soldered onto copper plates and operating on nine-volt batteries, always visible to the audience, with all other manipulations made by hand or with transparent plastic sheets. For some performances he constructs a transmitter in front of an audience as the first part of the piece, and the audience may gather around him for the building and performance.[14] In this way, Kogawa brings radio and magnetic fields into the realm of the human rather than the ethereal. No ghosts, no aliens, no spirits from the other side are invoked; rather, the focus is upon the human scale of radiophony, such that bodily and electromagnetic gestures have audible consequences.

If Kogawa's practice reveals a kind of minimalist approach to radiophony (he arrives ready to play with just a small bag of transmitters, batteries, and two receivers), other artists are creating interesting hybrid works that combine radio instruments with other soundmaking practices, while retaining the focus on feedback within a circuit of bodies and devices. Kogawa occasionally improvises with Knut Aufermann and Sarah

Washington, a duo who also perform under the name Tonic Train. In performance, Aufermann creates sound through three to four paths of feedback: feedback generated between a microwatt transmitter and receiver (further activated by his hand gestures), feedback from patching the outputs of a mixing console back into itself, ambient feedback from a live microphone in a container picking up the amplified signal of the performance, and feedback through various effects processors. Washington's circuit-bent original instruments (like the Feedback Phone) are touch-sensitive interfaces that activate short circuits to create new loops of unpredictable sound.[15] Washington and Aufermann's instruments also interact and interfere with one another. Tonic Train prefer to work within such relatively unstable systems that respond to human touch or gesture, as this Hertzian environment removes the element of total artistic control in favour of discovery and adaptation, pushing Washington and Aufermann to respond to current, live conditions as players within the circuit, truly improvising with their instruments as well as each other.

My own radio art practice has incorporated radio as instrument on multiple levels, where radio is the source, subject, and medium of the work. My more recent performance and installation pieces with multiple low-watt FM transmitters and an array of between 12 and 75 receivers (*La vida secreta de la radio*, 2005; *You are far from us*, 2006-2008; *Somewhere a voice is calling*, 2007, *Respire*, 2008) have resulted from a gradual process of introducing less rather than more stability into my interactions with radio waves. For these pieces, the radio receiver array is usually suspended from the ceiling of a venue and lit only by small LED lights, which creates a dim, visually static environment. The sonic static, however, is constantly in motion.

Installation view, *You are far from us*, Chapelle des Brigittines, Brussels, Belgium.

October 2007. Photo: Anna Friz.

For *Respire* and *You are far from us,*[16] the transmitters that I employ are low-power, varying in wattage from 50 milliwatts to 2 watts FM, and are effected by the spill from other existing licensed stations in the area (that operate much more powerful signals– up to 50, 000 watts). I also deliberately set the transmitters to narrowcast on related frequencies, thus encouraging multipath and harmonic interference with one other. As a result, the receivers emit twitters and oscillations of sound before I begin to direct any external sounds through the transmitters. Also, since FM operates on line-of-sight broadcast, audience members walking among the radios may interfere with the signal from the transmitter reaching the receiver, causing brief bursts of sound in one or a few of the receivers, and revealing the station or interfrequency static hidden underneath. Weather, time of day, construction of the building in which the array is housed, and the radiophonic environment all directly effect the sensitivity and volatility of the system, and the sounds heard. Into such a responsive radiophonic landscape I also transmit improvised and composed sound, favouring sounds that amplify and focus the radio environment of signal and noise (for instance, sampling theremin and VLF (recorded very low frequencies in the electro-magnetic spectrum) signals), and the so-called 'surplus' inadvertent sounds that bodies make on radio: intakes of breath before speaking, glottal admissions, hissing and popping air hitting the microphone, weight shifting in a chair, breath grown ragged, the overheard background from a live report, and so on. These samples of what might be called abject sound seep or explode into the thin heterodyne music of the radios in the array, directed to one or many radios at a time.

Radio maker Gregory Whitehead posits that artistic appropriations of radio "involve staging an intricate game of position, a game that unfolds among far-flung bodies, for the most part unknown to each other." (Whitehead, 1992, p. 254) Mobile and micro-radio art practices bring these formerly far-flung bodies into contact and context, and allow for something unexpected to happen. Radio as instrument, then, does not propose an instrumental or neutral use of radio; nor is this form of radio art, in the sense of direct manipulation or play with radio waves, a simple application of raw materials for artistic expression. Radio becomes a frame for a series of relationships, near and far; of visible gestures meeting invisible electromagnetic interactions, of a circuit built, played with, and played within. Gesture-or touch-sensitive, radio as instrument requires the capacity and capacitance of the body of the performer, and proposes a becoming-radio of the performer through embodied activation of radiophonic space.

These seemingly arcane practices of radio play engender a minor but fascinating trajectory for radio culture and technology. By sidestepping the relations of senders and receivers, radio as instrument returns focus to phenomenologies of radio and electricity, and to the materiality of the radiophonic environment. Hearing sounds that would seem to exceed the realm of the human and sensing fields of electro-magnetic activity is a very physical experience in which our bodies as performers and audience members are deeply implicated. Artistic interactions with radio waves also act on the imagination, and provoke considerations of radio entirely outside of content delivery or exchange models. However, aesthetic impulses and conventions around performance push even Kogawa's 'free' radio play toward a blurry intersection where music, noise art, and sound art meet, while performing radio still tends to take place in more conventional

settings such as the theatre or the gallery. But just as human bodies may effect electrical circuits by contributing capacitance, so too do these circuits of radio play add capacitance to our cultural imagination, conjuring other possible radio territories than the ones with which we are familiar, and adding intimacy to our understandings of radio and electricity.

Sound Links for this article:

Live set from Tetsuo Kogawa (fm feedback), Sarah Washington (circuit bending), Knut Aufermann (fm and audio feedback), recorded at M12 in Berlin, 2 Nov 2007. Original MP3 can be downloaded here

Suspend: excerpted from *You are far from us* (2006-2008) by Anna Friz 6:55

Text to accompany *Suspend*, an excerpt from *You are far from us*

Suspend is a 2-channel audio excerpt from an installation work entitled *You are far from us*. The installation contains five movements: inhale, suspend, witness, nocturne, exhale. The voices in the piece are sampled from radio news eye-witness and survivor accounts of people confronted by assailants with guns. Other sound sources include theremin, stopwatch, and walkie-talkies. This excerpt is a stereo remix of the composed sounds, without the in situ sounds of the installation.

The radio of the future as imagined by the past was filled with the promise of extraordinary extraterritorial union across distance and time. Spiritualists and scientists alike ardently hoped radio would allow access to realms of the uncanny; some believed that the radio would provide a connection with the dead or other ethereal spirits.

Meanwhile the radio of the present is filled with reports of the dead: casualties of war, of street violence, etc. Rather than dream again of the radio transmitting messages from those who have passed away, I wondered what communication we might be missing from those living around us. What nearly inaudible signals, transmitted in moments of intensity or crisis, might we hear if the radio was tuned to hear? What do people seek to transmit, in a moment between the intake of breath and the breath held, waiting, in tension? In listening for and imagining these signals, I seek to hear the desire for contact and witnessing in such liminal moments. Far from overcoming or eliminating distance as the purveyors of early radio proposed, with this piece I aim to bring people into intimate relations with distance, to hear and feel distance, and to empathize with unseen others who remain distant in time and space.

The installation consists of a multi-channel FM radio array, including up to four low-watt transmitters and 75 receivers. The radio receivers are suspended from the ceiling in a dark room, and then lit by very small LED lights. The transmitters are tuned to available frequencies that also overlap and interfere with one another, introducing thin tuning oscillations and crackles of static into the radio landscape in which the composed sound is situated. Each presentation of the work is site specific in terms of both the spatialization of the composed sound through the radios (arranged depending on the installation venue) and the volatility of the local radio environment. The responsiveness of this radiophonic circuit is purposefully subtle, and so the installation fares best in an intimate space such as a small room or a quiet corridor.

Notes

1. There have been and continue to be many possible models and practices of transmission (ranging from state-monopolized broadcasting, to community or pirate low-watt narrowcasting, to walkie-talkie networks, to signals sent from the Mars probe) which are shaped by communities of users as well as by state or commercial policies. I have proposed elsewhere that radio may consist of assemblages of communities, transmission technology, and discursive practices; see Friz (2006). However, my reference here is to the very persistent popular notion that continues to equate radio with broadcasting. For notable scholarly work on the diversity of radio cultures (both historical and contemporary social practices and communities) in North America, see Douglas (1999), Dunifer and Sakolsky (1998), Hilmes (1997), Squier (2003), Vipond (1992), and Walker (2001).

2. See for instance the case of Steal This Radio, a pirate station on the Lower Eastside in New York City that was shut down by a 400-strong NYPD riot police and assault unit (Dunifer and Sakolsky, 1998, p. 133-141). Many countries have rich histories of pirate radio activity, notably the UK, where a high number of pirate stations continue operating in London alone (see Fuller, 2005).

3. Television's proliferation into middle-class and working class North American households in the 1950s and 60s displaced radio as the dominant transmission medium and fostered predictions of radio's imminent demise. But though video didn't actually kill the radio star, the death knell was definitely tolling once more for radio by the turn of the 21st century. "Who needs radio anymore? TV talent shows, Internet give musicians new access to fans." Carolyn Brown, msnbc.com http://www.msnbc.msn.com/id/3341465/ (accessed January 19, 2009)

4. Many regard webcast services such as podcasting or streamed online radio stations as the next chapter in the life of radio (for instance, see Smith, 2008). Meanwhile, terrestrial radio remains the dominant media form in many countries in the world, for its continued cheapness, portability, and accessibility (see Girard, 2001).

5. Regenerative circuits both amplify and transmit radio waves through feedback–by feeding the output signal from an audion or vacuum tube back into itself, the signal is amplified. When operating at maximum amplitude, the vacuum tube itself begins to produce independent and sustained oscillations of its own. This mechanism was developed by Edwin Armstrong and used to increase sensitivity for early AM receivers (Glinsky, 2000; Settel, 1960).

6. See Glinsky (2000) and Steven M. Martin's documentary film Theremin: an Electronic Odyssey, 1994.

7. Theremin earned a diploma from the St. Petersburg Conservatory parallel to his studies in physics. The cello is a fretless stringed instrument, where the player uses the left hand to press on the strings to control pitch. The closer to the bridge of the instrument that the strings are pressed, the higher the pitch. Thus cello players, like violin and viola players, must find individual notes on their instrument without definite reference points: unlike a tuned piano where pressing the middle "C" key will definitely

result in the note "C" being played, a cellist must locate the correct position for any given note by ear. Smooth glissando effects are possible by sliding the fingers along the string while maintaining pressure.

8. For an extensive if incomplete list of bands that have used the theremin, see http://www.thereminworld.com/bands.asp (accessed January 19, 2009).

9.
See http://www.free103point9.org/studycenter/historicaltransmissionworks/ (Accesse d January 19, 2009).

10. For instance, see Burtner (2003). Notable festivals supporting this kind of inquiry are WAVES (2006) and Spektropija (2008), both produced by the RIXC Centre, in Riga Latvia. "WAVES was conceived as an exhibition and event that particularly emphasizes works of artists who circumvent the layer of meaning–as in any type of semantic or symbolic/visual structure transmitted by using waves simply as a carrier of information–and who work directly with the materiality of waves, their physical properties and characteristics…" (Medosch, p. 18).

11. Kogawa continues to teach transmitter building workshops internationally and plans can be found at his website: http://anarchy.k2.tku.ac.jp/radio/micro/howtotx.html

12. "La radia shall be: […] 17. The utilization of interference between stations and of the birth and evanescence of the sounds." F.T. Marinetti, Pino Masnata, "La Radia". 1933. http://www.kunstradio.at/THEORIE/theorymain.html

13. From question and answer period after Kogawa's lecture "Re-Examining Radio Art" at Radio Without Boundaries conference, Toronto, Canada, June 1, 2008.

14. For instance, for Kogawa's performance at *RadiaLX* 2008, on 23. September 2008 at the Goethe Institute in Lisbon, Portugal, the audience tightly encircled Kogawa's table to observe and listen, http://radialx.radiozero.pt

15. Circuit-bending is the creative repurposing of consumer technologies to make performance instruments by directly manipulating the circuit boards and cases of the electronics– in this case, to create new instruments to generate sounds. Circuit bending is hardware hacking, and is less a nostalgic return to analogue tinkering than a desire to sidestep the factory presets and expense of commercially available electronic instruments in order to create cheap and personalized interfaces to play. See Collins (2006) and Ghazala (2005). Tim Kaiser's circuit bent instruments and optical theremins are also worth noting for their utterly unique interfaces that repurpose many old laboratory and other salvaged vintage materials, http://www.timkaiser.org/project5.html (accessed January 19, 2009).

16. You are far from us premiered at *Radio Revolten* in Halle, Germany (2006), and has subsequently been shown at Radiophonic 07 in Brussels (2007) and *Art+Communication: Spektropja* in Riga, Latvia (2008), with generous support by

the Canada Council for the Arts, and the Conseil des arts et des lettres du Québec. Respire is a piece that has grown from *You are far from us*, focussing the composition on breath, and emphasizing the detuned radio landscape amplified by the radio receiver array. *Respire* premiered at *RadiaLX* 2008 in Lisbon, Portugal (2008), and will be performed in 2009 at *Sound Thinking* 2009, Surrey Arts Centre, Surrey, British Columbia, and Scotiabank *Nuit Blanche*, Toronto.

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Biography

Anna Friz is a sound and radio artist, and a critical media studies scholar. Since 1998 she has predominantly created self-reflexive radio art/works for broadcast, installation or performance, and has extensively presented her work internationally. Her radio art has been heard on the airwaves of more than 15 countries. Anna Friz is a SSHRC Doctoral Fellow and Ph.D. candidate in the Joint Program in Communication and Culture at York University in Toronto, and a free103point9 transmission artist.