CHAPTER 5

Multimodal Scholarship in World Soundscape Project Composition: Toward a Different Media-Theoretical Legacy (Or: The WSP as OG DH)

Jonathan Sterne

In this chapter, I reconsider the World Soundscape Project's (WSP) media practices as media theories in action (or The WSP as OG DH).[1] I listen to and analyze two canonical works, Hildegard Westerkamp's *Kits Beach Soundwalk* (1989) and Barry Truax's *Riverrun* (1986), to consider them as examples of media theory in the sonic register. I argue, anachronistically, that these works are examples of *multimodal scholarship* before that term came into existence. In doing this, I hope to help bring sonic histories and practices more fully into discussions of the digital humanities while also offering an alternative to the ways in which media theory coming out of the World Soundscape Project is usually discussed.

As Tara McPherson explains, multimodal scholars bring together "databases, scholarly tools, networked writing, and peer-to-peer commentary

J. Sterne (✉)
McGill University, Montreal, QC, Canada
e-mail: jonathan.sterne@mcgill.ca

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while also leveraging visual and aural media that so dominate contemporary life" (2009, p. 120). They consider how arguments are experienced or felt in more "sensory-rich" spaces than writing alone. While traditional scholarship privileges writing as its ideal mode of dissemination, multimodal scholarship might juxtapose sounds and images with writing; it might produce nonlinear forms of writing aided by digital navigation; or it might use media like sound recordings, videos, or games, where writing takes on a secondary or supporting role. In her discussion of multimodality, ~~Kathleen~~ Katherine Hayles refers to the "full range of visual images, graphics, animations and other digital effects," arguing that the best projects "have emotional force as well as conceptual coherence" (2012, p. 40). Writing of digital technologies, McPherson argues that:

> hands-on engagement with digital forms reorients the scholarly imagination, not because the tools are cool or new (even if they are) or because the audience for our work might be expanded (even if it is), but because scholars come to realize that they understand their arguments and their objects of study differently, even better, when they approach them through multiple modalities and emergent and interconnected forms of literacy. The ability to deploy new experiential, emotional, and even tactile aspects of argument and expression can open up fresh avenues of inquiry and research. (2009, p. 121)

Yet the theories and tools of the digital humanities have been heavily visualist and textualist in orientation, in part because of the digital humanities' institutional histories, and in the operational privilege of text over sound in many digital media applications (Lingold, Mueller, & Trettien, 2018, pp. 9–10). Even massive audio archives and collections require metadata in the form of text to make sounds searchable, identifiable, and retrievable (Morris, 2015). While multimodal publication tools like Scalar and Manifold have audiovisual capabilities, their video players have been developed long before dedicated audio players, which reflects the disciplinary interests of the scholars building and using them. In part, this bias reflects the wider commercial priorities of web application developers, who also often treat audio as a secondary concern.

If the digital humanities is to be understood as emanating from fields like literature, film studies, and visual culture, there is a story to be told about overcoming the opposition between criticism and production because of those fields' historical emphasis on that opposition. But not all disciplines work that way. In fields like engineering and computer science, that opposition makes no sense. So too for acoustic ecology, which was

heavily influenced by the ideas behind modernist composition practices. To foster new orientations to music and sound, intellectually oriented composers appropriated intellectual trends from outside music: from information theory (Karlheinz Stockhausen, Pierre Schaeffer, Iannis Xenakis), to lesbian-feminist utopianism (Pauline Oliveros), to ecology (Hildegard Westerkamp, R. Murray Schafer), to Western digestions of Buddhist and Taoist philosophy (John Cage).

The compositional, collecting, and radio practices of the World Soundscape Project thus fit into a longer tradition of technologized humanism. As both McPherson (2018) and Hayles suggest (and they are far from alone in this respect), the move from critique to critical production is occasioned by the proliferation of digital technologies. But the humanities have long been technological. Digital tools are simply more apparent as technologies because of their relative novelty. Crotchety colleagues have sometimes responded to the millenarian rhetoric of digital humanities by positing "analog humanities" as an alternative, even borrowing from vinyl record collectors to call for a revival. I wish to imply neither nostalgia nor revivalism. In an essay on the history of humanistic uses of examples, I used the term "analog humanities" to refer to humanists' uses of analog media technologies—and the analog components of digital technologies—in academic settings and in print. The parallel with *digital humanities* is intentional; both terms refer to complexes of technologies and engagements, without specifying any particular discipline (Sterne, 2015).

As Lisa Gitelman writes, "Media history offers access to the epistemologies and interpretive practices of the humanities at a vernacular as well as scholarly or academic level […] media aren't instruments of scholarship in the humanities; they are the instruments of humanism at large …" (2006, p. 153). If we recognize the long-term multimodality and mediality of humanistic scholarship, then it is perhaps not radical at all to incorporate new technological modes into our work. But just as the institutional shape of education is changing—due to a mix of changes in hardware and a series of political economic shifts—so too are our orientations to our tools and, through our tools, the texts and artifacts we study and the ideas we advance.

This is where a rereading of the World Soundscape Project's media work may be useful. Unlike humanists' use of dual slide projectors for art history lectures and mimeograph machines and cameras and darkrooms for their documentary practices, the use of sound recording in academic settings was flagged as "technological" at the time because it was specialized and expensive. It is also easy to recognize as technological today

because of the ways in which sound recording is *still* considered to be a specialized, technologized practice even though most people in industrial societies do it as a matter of course. The overlap between scholarship and consumerism is also important here: today, both teachers and students walk around with devices in their pockets more powerful than the entire studio at Simon Fraser University in the 1980s. Yet as I discuss in the following paragraphs, there is a powerful ideology that still treats sound recording (and audio practice) as a specialized skill, as opposed to photography or video editing.

The World Soundscape Project's media practice has *already fulfilled* some of the ambitions for the digital humanities; it could be a useful touchstone for scholars who want to make arguments through and in sonic registers. This is why, tongue in cheek, I call the WSP "O.G. DH."[2] Most often, when the WSP comes up in media theory, R. Murray Schafer's writings are held up as the group's main theoretical contribution. And in recent years, Schafer's ideas have come under heavy criticism from media theorists. His concept of schizophonia mobilizes disability stigma to argue that the mediation of sound is inherently psychologically damaging, a position that trivializes mediation and, importantly, ignores that all sounds are "separated from their sources" (Stanyek & Piekut, 2010). His concepts of noise are inherently anti-urban and work with, rather than against, notions of noise that are used to control and stigmatize racialized and minoritized populations (Blake, 2010; Radovac, 2015). His concept of soundscape is too broad, susceptible to the many critiques of landscape as a totalizing phenomenon in art history and geography (Akiyama, 2010; Thompson, 2002).

Yet a focus on Schafer's *writings* has obscured a focus on the WSP's *practices*. Considered in their fullness, these practices often directly contradict the media theories advanced in Schafer's writings. Several strands of media studies have treated media practices and technologies as operative theories: writers like Gilles Deleuze (2001), Friedrich Kittler (1999), and Wolfgang Ernst (2016) have considered time-based technologies like cinema and sound recording as philosophies that comment on the nature of temporality and subjectivity or, rather, the very possibilities of those phenomena. Lisa Gitelman (2006) has treated the sound recording as a meditation on the nature of all sorts of records and documents. Wendy Chun (2011), Alex Galloway (2012), and Sumanth Gopinath (2013) have considered software processes as theories of ideology and subjectivity. Media art histories have considered sonic artworks as philosophical meditations

on the nature of capital, subjectivity, and nature (Curran, 2010–2018; Dyson, 2009; Eidsheim, 2015; Kahn, 2013; Kelly, 2009; Knouf, 2016). And my own monographs (Sterne, 2003, 2012) consider the theories of subjects that are directly built or written into auditory technologies from vibrating membranes in the nineteenth century to audio codecs in the twenty-first century.

"Theory" here refers to two different referents, which should be clear from context but are not the same thing. *Media theory* denotes an interdisciplinary field of discussion about how media work, why they matter, and so forth, just as literary theory does the same for literature and anthropological theory does the same for culture. However, a *media theory* is not simply a comment on that intellectual field. Rather, a *theory* is a description of the world with explanatory or predictive power. To confuse the former with the latter is to obscure what makes actual theories useful: they help us explain, describe, or predict aspects of the world. In the context of scholarship, "takes" on the works of other authors are commentaries, but lack that explanatory power. My commentaries on other authors in this chapter do not constitute *a theory* but may be part of the dialogue within the field of *media theory*. Conversely, I am arguing that the two pieces I examine in detail later should be understood as themselves offering theories of media and sound because they have explanatory power.

To analyze the WSP's media practice as a working set of media theories, we will have to move beyond the ways their work is usually discussed—as art and as documentary practice. The many sonic practices undertaken by the World Soundscape Project were not generally narrated as a kind of humanistic work. The three main figures I consider in this piece—Hildegard Westerkamp, Barry Truax, and, parenthetically, R. Murray Schafer—all refer to their sound work as *composition* and have labored, with great success, to have their output understood within the global economies of "serious" composed music and sonic artwork. While I have no interest in challenging the terms on which they are evaluated in that sphere, I bring a different hermeneutic to their work. In this essay, I will evaluate two exemplary works as argumentative, demonstrative, and didactic—and not as art. I will not consider their work in terms of artistic vision, originality, or integrity according to the avant-garde compositional ideals operating in their time or ours. Rather, I want to consider this work as a precursor of the kind of multimodal scholarship that is now being done under the flag of digital humanities.

Thus, this chapter considers the WSP's media work (alongside their writings, but not necessarily interpreted through them) as theoretical and pedagogical in and of itself. To do this, I offer readings that may contradict published writings and statements by WSP principals in order to reread the past to produce a story that may be more useful for the present (White, 1966). My reading is intentionally anachronistic and anti-intentional: it considers work in the 1980s through the debates of the 2000s and 2010s; it somewhat discounts the ways in which Westerkamp and Truax talked about their work in order to cast it in terms contemporary to us now, rather than to their context then. I have intentionally not asked either of them if they would imagine their older work in terms of the digital humanities. In his critique of historicism, Jonathan Rée wrote that "There is no good reason why the thought of a period should not be judged by the standards of another" (1991, p. 979; see also Leslie, 1970). That is what I aim to do here, in the service of using past work as a resource for imagining possible futures.

Hearing and Playing *Kits Beach Soundwalk* Didactically

Hildegard Westerkamp's *Kits Beach Soundwalk* is one of her most famous works, showing up in reviews of avant-garde music in the twentieth century, in catalogs of WSP practice, and on course syllabi.[3] One notable reading of the piece comes from Tim Rutherford-Johnson, in *Music After the Fall,* a review of avant-garde composition after 1989. Rutherford-Johnson finds it exemplary because it does not rely on a score, yet it reflects a "painstaking and reflexive period of composition,"[4] evidenced by careful placements of sounds so they do not mask one another (p. 4).

To understand my reading of *Kits Beach* as an example of *didactic* work, it is helpful to understand how it built on Westerkamp's radio program *Soundwalking*, which was featured on Vancouver's co-operative radio station. Westerkamp wrote that she wanted to create radio that "inspires us to invent; […] refreshes our acoustic sensitivity; […] stimulates listening; does not repeat; […] encourages us to sign or to speak, to make radio ourselves […] instead of merely broadcasting at us" (Westerkamp, 1994, p. 89). In some ways, this is a fairly standard critique of the unidirectional format of late twentieth-century commercial broadcasting, but unlike many of the mass culture critics who had been making the same point

about overcoming passivity for some time (most famously Adorno and his critique of the listener), Westerkamp framed her radio work as pedagogy that promoted an alternative social vision of sound, and of media.

> I was attempting to make radio a place of environmental listening by broadcasting the soundscapes that listeners experienced in their daily lives. With that I had hoped to create a state of resonance within listeners so that when they encountered sounds in the actual environment, recollations of the radio broadcast would alert them to the soundscape in which they lived—creating participating listeners, that is, listeners of the broadcast who could then also be receptive to the soundscape as a whole. (1994, p. 88)

Westerkamp clearly describes her radio work as related to music composition and aesthetic practice, yet one is struck by the similarity between the goals in Westerkamp's broadcasts and the kinds of things teachers like me hope to accomplish in undergraduate courses on sound. It is ultimately a pedagogical and orientational goal: for the audience to be more aware of its environment; for listeners, through instruction and practice, to develop the skills and techniques in order to listen to it; and for listeners to be motivated to engage with their environments in ways other than those prescribed by commercial media or common sense. One can even read the program like a syllabus, where the problem of listening to the environment was explored from a different location each week. For different episodes, Westerkamp and her tape recorder and microphone visited "a shopping mall, park, zoo, factory, residential area located under a flight-path and the streets of Vancouver" in order to "present everyday acoustic environments from a new angle" (Westerkamp, 1994, pp. 89–90). In the composer's note for *Kits Beach*, after summarizing her *Soundwalking* radio work, she writes that *"Kits Beach Soundwalk* is a compositional extension of this original idea" (Westerkamp, 1989) in that it combines environmental recordings, studio production techniques, and Westerkamp's didactic narration.

Readings of the piece by Brandon Labelle and Tim Rutherford-Johnson focus on a pivotal moment (for the fullest textual exposition of the piece, see McCartney, 1999, pp. 218–222). After setting the scene of a calm winter morning in January at Kits Beach in Vancouver, she focuses on the sounds of the barnacles: "I'm trying to listen to those tiny sounds in more detail now. Suddenly the background sound of the city seems louder again.… Luckily, we have bandpass filters and equalizers. We can just go into the studio and get rid of the city, pretend it's not there. Pretend we

are somewhere far away." Rutherford-Johnson describes this moment of the piece as one where it "does exactly that: the city's low road is filtered away, leaving only the click and suck of the barnacles" (p. 14). The piece is meant to draw listeners' attention to those particular sounds, but it equally can draw attention to Westerkamp's own agency as an engineer in the studio. This is a crucial point because the combination of commentary and signal processing draws attention to the artifice of the recording itself. Brandon Labelle notes something similar when Westerkamp says, "I could shock you or fool you by saying the soundscape is this loud," as she turns up the volume of the background sounds, "but it is more like this," as she drops them down again. Labelle considers this a double move: "Such play opens up a space within the recording that accentuates her actual presence in the real environment while revealing the compositional components of constructing what we are hearing" (Labelle, 2015, p. 206).

Let's extend Labelle's observation. The performative doubling at these moments in *Kits Beach Soundwalk*—Westerkamp was actually there and Westerkamp actually manipulated the recordings—illustrates the fundamental phenomenological contradiction of recordings: they can be experienced as *both* indexical signs and semantico-referential (which is to say arbitrary) signs (Peirce, 1955). Understood socially and mechanically, audio recording and reproduction systems are lengthy chains of cause and effects. From the sound of Westerkamp's voice, a listener infers that she once spoke. From the sound of the barnacles, a listener could infer that she was once near them, even though neither is *necessarily* the case. This is the case for recording as indexical. Westerkamp's vocal and gestural performance mounts a case for the arbitrary nature of recording: the relation between foreground and background is entirely malleable and its meaning is further inflected by commentary. In *Kits Beach Soundwalk,* that commentary exists within the recording; but meaning for sound recordings can just as easily emerge paratextually, which is to say outside the recording itself, as in the case of music genres (Brackett, 2016) or of the silence in the Nixon tapes (Kim-Cohen, 2018). All of these propositions are manifestly performed and narrated in *Kits Beach.* They are expressed didactically, which is to say the piece can be heard to be making an argument.

Compare my explication of *Kits Beach*, as a kind of media theory, with Jason Stanyek and Ben Piekut's (2010, all quotes that follow are from p. 19) written theory of recording as media form—not to authorize her text (it doesn't need authorization) but rather to think across two modalities. They draw attention to the artifice of recording through a suite of

characteristics that they can name and describe but not perform in a print medium: "*Revertibility* refers to a temporal process of undoing a work of recording in some way, whereby presumptive wholes can be disarticulated and taken back to a prior stage in a process of assemblage, upsetting straightforward, cumulative forms of co-labor." When Westerkamp plays with filtering, she demonstrates *and explains this process* in her own terms. When Westerkamp calls attention to her editing and microphone placement, she performs a kind of *recombinatoriality,* which Stanyek and Piekut describe as "the capacity toward articulating what are taken to be discrete, non-identical parts into new arrangements." Another point of overlap is in Stanyek and Piekut's use of the term *deadness* as an alternative to "the unhelpful and overvalued schism between presence and absence that undergirds" many media theories (p. 20). Westerkamp's didactic shuttling between indexical and arbitrary modes of signification makes the same point.

This is echoed in some of the listener responses that Andra McCartney cataloged, in what is no doubt the most extensive research on the piece to date. McCartney played the piece for Vancouver locals as well as for a range of other audiences. Listeners suggested genres beyond musical composition for it, likening it to a soundscape story, oral documentary, and radio shows, though, as McCartney notes, the piece does not exactly conform to any of these formats (pp. 224–226). Westerkamp's reference to her own production process drew a laugh from every audience for whom McCartney played the piece, because it self-reflexively undermines its own rhetoric of objectivity as a documentary or as a sound recording (p. 230).

Several listeners also noted what Westerkamp would have called its schizophonic dimension, and Stanyek and Piekut would call its rhizophonic dimension: "'The view is beautiful,' No it's not. […] I don't know this space" (p. 232, see also pp. 234–236). For these auditors, spatial listening is ambivalent. When writing about the separation of sounds and sources, Westerkamp uses Schafer's schizophonia concept to argue that it is a problem when there is a difference between what is heard and seen in an environment because it has separated the listener and the environment (1988, pp. 26–34). Conversely, Stanyek and Piekut use the term *rhizophonia* to claim that *all* sounds are separated from their sources by definition (2010, p. 19). I am much more sympathetic to Stanyek and Piekut's interpretation—it's not a problem that Westerkamp is there and McCartney's auditor is not. But my goal is not to point out a contradiction between Westerkamp's writing and audio work and its reception in

order to critique it. Rather, I highlight the contradiction in order to show that Westerkamp's audio work can be heard through entirely different hermeneutics from her writings; to different ends; and that such hermeneutics are equally valid.

Several of McCartney's listeners also noted the pedagogical dimensions of *Kits Beach Soundwalk*. This is no accident. Westerkamp's audio work is an extension of a well-defined pedagogical project in her writings and public lectures, from her classic 1974 soundwalking essay on down to more recent work (e.g., Westerkamp, 2007, 2010). And in turn that work extends and refines ideas in R. Murray Schafer's writings in *Ear Cleaning* (1967), *The Soundscape* (1994), and elsewhere. But that is precisely the point: *Kits Beach Soundwalk* is designed to actuate the mode of listening it wishes to inspire, and it does so through the sonic equivalent of diagrams and illustrations, as one might find in a book or presentation. In the visual domain, this is customary and common; in the audio domain, it is still rare to find audio examples next to the language describing them, and even notable digital humanities platforms like Scalar and Manifold still have video capabilities that far outstrip their affordances for working with audio. This is why it is useful to look back at Westerkamp's work as a precursor to the multimodal scholarship so central to digital humanities today. In *Kits Beach* and in her radio work, Westerkamp provides a model for using sound didactically, for teaching with it through media, and for disseminating work outside the normal academic channels.

At the end of his introduction, Rutherford-Johnson notes that Westerkamp's work challenges what is normally thought of as Western Art Music, showing that the borders of the term have become "highly permeable and fuzzy" (2017, p. 21).[5] But its status as scholarship should be uncontroversial: it is an exceptionally effective teaching tool in the modern sound studies classroom. For the past few years, in my large-lecture undergraduate sound studies course, I asked students to listen to *Kits Beach* as their first introduction to audio recording as an aesthetic practice (at least for many of them). I then ask them to work with clips from the recording in Audacity, a free audio editor, after some basic instruction from me. This is one of the best days of the term, as students who had never thought they could or should work with sound aesthetically take great delight in editing, manipulating, and transforming Westerkamp's words, sounds, and messages (they have also occasionally recorded me giving the Audacity instructions and mixed those in for fun as well). This sets up a unit on the theory of sound recording, starting

with Stanyek and Piekut's essay. Because students have heard Westerkamp and worked with sound themselves, the phenomena described by Stanyek and Piekut—which read as words alone might seem highly abstract for someone who has no experience with sound recording and editing—become more concrete.

It also makes a difference that my undergraduate classes include, year after year, majority female members. That it is Westerkamp giving the instructions and providing the raw material is not accidental. Andra McCartney recalls that "I first heard Westerkamp's music in 1989 […] it had a galvanic effect on me: I wanted to compose electroacoustic music so much that I went out, rented equipment, and began within days of that first listening" (1998, p. 6). The gendered dimensions are important here. As recent scholarship has amply documented, women and gender nonconforming people are still often heavily discouraged from thinking of themselves as entitled to, or capable of, working with sound as a material, using recording technology (Born & Devine, 2015). This *practical* knowledge of recording—made possible through the group audition and discussion of Westerkamp's piece and group experimentation with audio software—provides a firm basis for much deeper cultural readings of recording as a process, such as the Stanyek and Piekut piece referenced earlier, and critical writings on the voice, mediality, and power that follow in the course outline (for the 2018 version of the course, see: http://sterneworks.org/COMS350-W18.pdf). My integration of the piece into my course is built entirely on this reading of it. One can certainly appreciate *Kits Beach Soundwalk* as art, and that appears to be the dominant mode of writing on it, but I hope I have demonstrated it is also possible to appreciate the recording as pedagogy, and thereby to appreciate it as a precursor to digital humanities practices that are more common today.

Read against Westerkamp's description of her own radio practice, it is no coincidence that the vast majority of sonic-pedagogical work—work that is designed for and within a sound studies framework broadly conceived—exists as podcasts. "Radio-like" (Freire, 2008) in their format and styling, free to move beyond the commercial imperatives and constraints of radio, and serialized through RSS, sound studies podcasts have, decades later, taken up the mantle of sonic education through sound. Most notable in this field is the impressive collection of recordings made in connection with *Sounding Out!: The Sound Studies Blog*, which document a host of sonic practices, ways of sounding and listening, and an impressive, international, and intersectional array of sonic

experiences unconstrained by a common format (https://soundstudies-blog.com/podcast/). *Phantom Power: Sounds About Sound* explores sonic arts and humanities through long-form interviews and high-concept composition and programming (http://phantompod.org/about-us-2/). Sound scholars are still not at the point where we can insert sounds in our printed texts like we can images, but that time will come.

In the meantime, the most successful alternative to silent textuality in sound studies is *Sounding Out!: The Sound Studies Blog,* which could be read alongside DH projects that refuse high dollar aesthetics and expensive infrastructure of digital humanities projects, such as the Minimal Computing (see https://go-dh.github.io/mincomp/). They use ready, off-the-shelf blogging software, borrow audio and video hosting from Soundcloud, YouTube, and other commercial platforms, and provide access to the field for people who otherwise might not have it. "Our move to combine craft production with a group experiment in digital community building came from a desire to push the rhetorical boundaries of sound studies and the sensory nature of 'writing' itself" (Trammell, Stoever, & Silva, 2018, p. 91). This is not to say that their solution is perfect—dependence on corporate platforms comes with significant compromises. But the long run of the blog shows what is possible, and it has done more than any publication organ in the field to expand its reach and provide access for emerging scholars, who most need access to publicity about their work.

Meanwhile, in our classrooms, we have reached the point where audio playback is possible and even sometimes easy. Our students can both record and play back the sonic world outside of our classes. The World Soundscape Project's commitment to pedagogy existed in a very different moment, where it was simply a radical thing to make one's own media and to separate one's sensibilities from those of the mainstream media. Our challenges today are different, but not too different. The tools may now be available, but increasingly, the major obstacles to their use are ideological and inertial. Westerkamp's patient, pedagogical voice is a model and a resource for teaching with and through sound.

Riverrun: Performing New Sonic Temporalities

"Barry Truax!"

These were the first two words spoken to me by Gerhard Behles, one of the inventors of the software program Ableton Live, and president of

Ableton. It was 2012, and I was visiting Ableton's headquarters, in an effort to understand the software's particular relationship to sonic time. For those who don't know it, Live is the Power Point of electronic music software[6]—ubiquitous in electronic music settings—because it provides musicians with a way of using their laptops as electronic instruments in real time for performance. One of Live's core features is time-stretching, which reprocesses audio clips recorded at different tempos so that they can play together at the same tempo, or proportionately matched tempos, without changing the pitch or other signature dimensions of the sound like envelopes and transients. This feature can also be used and abused for creative purposes, especially in more extreme settings (where envelopes and transients take on new characteristics). Originally, Live's time-stretching feature was built around granular sampling, a process Barry Truax helped popularize by engineering a way to do it in real time in the late 1980s.

Behles learned about Truax's work on real-time granular synthesis and sampling while a student at the Institute of Sonology at The Hague (author interview, 2012).[7] But Behles' greeting to me provides a window into a reception history of Truax's ideas about sonic time, as embodied in his computational and compositional practice. Behles described Live's time-stretching techniques as "fucking with time," by which he meant that time-stretching technology in Live—distantly derived from Truax's work (among others)—allowed artists and musicians to explore novel relationships between sound and time. When played back on an acoustic phonograph or through a standard pulse code modulation (PCM)-based digital playback system, the pitch of a sound recording will vary with its rate: faster playback leads to higher pitch; slower playback leads to lower pitch (Pohlmann, 2011; see also Feaster, 2011, for a discussion of the aesthetic implications of this phenomenon). Granular processing is one of a group of analog and digital technologies that does away with this relationship: sounds can be sped up or slowed down with the pitch maintained, or pitches can be shifted with no change in playback speed.[8] In the 1970s at the University of California Santa-Barbara, Curtis Roads found a way to realize this process in the digital domain. Barry Truax's work in the 1980s allowed this process to be done in real time and, therefore, to be subject to real-time control by a musician or a performer (Roads, 1988). This is why it was notable for Behles.

Whereas most sound synthesis had been built on theories of sound that decompose it into infinite waves of particular frequencies, granular synthe-

sis and sampling treat sound as composed of particles that have a definite frequency-duration relationship. Drawing on theories advanced by Dennis Gabor (1946, 1947), Iannis Xenakis (1992), and others, granular processes compose audio from these "acoustic quanta"—minimal divisible units of sound (Roads, 2004).[9] Today, most of the processes called granular synthesis are, in Truax's nomenclature, species of *sampling* or *resynthesis*, where they take recordings of sounds as their basis for granulation, rather than generating the material basis for the granulation themselves. Truax developed a real-time approach to granular synthesis before he developed real-time granular sampling (see Roads, 2004), which is why *Riverrun* is built off synthesized sounds while later works are built off recordings—first phonemes in *Wings of Nike* (1987) and then eventually full environmental sounds, as in *Pacific* (1990). By 2000, real-time granulation on standard, consumer-grade computers with consumer sound cards was commercially available in programs like Pure Data (1996), Cycling74's Max/MSP (1997), Native Instruments Generator (1998), and Audio Ease's Riverrun (2000), the last clearly named for Truax's piece.

Over five major movements, played over four channels (a stereo version is also available), *Riverrun* ebbs and flows, from small clicks and bleeps to huge onrushes of sound that fill up the audible spectrum (see Bouchard, 2009).[10] To add some texture to this inadequate verbal description, on October 25, 2018, I conducted a listening session at the Sound Studies Listening Group at Northwestern University (SSLG, pronounced "slug"; organized by Jacob Smith), where I played a stereo version of *Riverrun* for an attentive audience of sound scholars and less "expert" listeners. As is their practice, I offered little context beforehand, though afterward, I explained my interest in the work. I did this to get outside my own head as a listener, in part because my own listening to the work was so motivated and shaped by the process of its production and Truax's (and critics') discourses around it, which might well fall into a discourse of authorial intent. Several striking things emerged from the conversation.[11] First, for a group used to thinking about sound but *not* necessarily familiar with granular processing as a sound production process, the people in the group immediately turned to a version of causal listening. The goal here was not to identify causes, as Michel Chion (1994) would have it, but to develop a vocabulary for describing what they hear through comparison—what it sounds *like*. Here people hear vastly different things: machinic and grating versus oceanic and flowing. This eventually coalesced into hearing the piece as working through the relationship between "the natural" and

"the digital," but here the piece was generally heard in a romantic relationship to nature. This is in part based on the heard relationship between the sound and the name of the piece, taken from the first word in James Joyce's *Finnegans Wake*, which is itself a meditation on sleep and waking time, and therefore on consciousness. Prompted by a group of music theorists in the room, especially Mark Butler, we moved from these more direct connections to a consideration of form. There is very little silence in the piece—there are no conventional rests. This constant fullness over almost 20 minutes prompts a consideration of the spatiality of sound—as if one were "inside" it. Another set of contradictory hearings focused on embodiment versus disembodiment: some heard themselves being pulled out of their bodies; others heard a queering of sound, and an ambiguous, nonbinary gender performance, especially as sounds and movements blended into one another. Still others pointed to the different scales at which the piece operated, from the individual grains up to the entire structure. One listener called it "sneaky…it is teaching you to listen for resemblances."

Apart from that last comment, *Riverrun* is not didactic in the same way that *Kits Beach Soundwalk* is. It may be heard as trying to teach its auditors to listen differently, but it is doing so in the manner of many twentieth-century avant-garde musical works. There is no voice giving instructions, aurally pointing to a phenomenon and saying "Now listen to *this*." Yet, if we zoom out, *Riverrun* can be read as a meditation on the plasticity of sonic time and space because of the method of its composition and because of its particular sonic structure. Here, I want to consider the piece and the process behind it, granular synthesis, as an argument about sound. Truax himself made this argument in several forms. In "Capturing Musical Knowledge in Software Systems" (1991), he argues that musical software is a representation of ideas about sound. Traditional software for composers had been built around a literacy-based model of composition, as a replacement for the pen-paper-piano-score-reading-musicians assemblage that had been hallmarks of avant-garde composition for centuries. Crucially, Truax notes that technical limitations are not the key issue: "The strongest limitation is probably not physical or contextual constraints, but rather the individual's attitude toward compositional process" (p. 220). To this end, he viewed software instrumentally, using a stable but probably already-obsolete DMX-1000 system, as something that should be developed in order to produce "a critical mass of open-ended control possibilities for the user," today an axiomatic dimension of music software design, but in 1991 a somewhat radical proposition, especially in comparison to

approaches to software at large computer music centers such as CCRMA at Stanford and IRCAM in Paris (see Born, 1995; Nelson, 2015).

Truax's system for *Riverrun* thus had a knowledge component, a particle theory of sound; a processing component, granular synthesis; and a praxeological component that enabled flexible, real-time control for the musician. Theoretically, granular synthesis challenged prevailing conceptions of pitch, time, and scale. "The basis of granular synthesis in the seemingly trivial grain has had a powerful effect on my way of thinking about sound. It clearly juxtaposes the micro- and macro- levels, as the richness of the latter lies in stark contrast to the insignificance of the former" (1990, p. 123). Sound synthesis had traditionally happened on a macro scale, based on sounds that corresponded to basic mathematical functions—most notably the sine wave—as the fundamental building blocks of sound. This was important for subtractive, additive, and frequency-modulation-based approaches to synthesis (see Nelson, 2015; Rodgers, 2011a, 2011b). Each of these approaches is in turn built around Josef Fourier's theory of heat as it was applied to sound in the nineteenth century (Hui, 2013; Kittler, 2017; Krämer, 2006; Pohlmann, 2011). A core characteristic of this math was that the waveform was theoretically infinite: it was defined purely in terms of its frequency, or how many times it cycles per second. But as Denis Gabor pointed out, sounds are not infinite: they have a definite duration (1947, p. 591, see also Gabor, 1946). Moreover, their duration affects the possibility for perceiving frequency both because of the physics involved and because of the limitations of human hearing (1947, p. 593).

Therefore, in contradistinction to the theory of sound as a continuous wave, which still pervades humanistic discussions of the materiality of sound, Gabor posited the existence of an acoustic quantum, the smallest unit of discernable sound (p. 592). It is a measurement of two quantities in relation to one another: frequency and duration. The result, as Curtis Roads has shown (2004, pp. 1–42), is that basic musical concepts like pitch and rhythm are challenged as absolutes: they only exist at one or another scale. Based on his reading of Gabor's critique of Fourier, Truax considered granular synthesis as one of a set of techniques that inaugurated "The End of the Fourier Era" (1992, p. 29). Among the ideas he hoped to push beyond are acoustic models that assumed perceptual absolutes (like the separation of pitch and rhythm), stimulus-response-based psychoacoustic models based on independent variables, models of composition drawn from the technics of literacy concepts like harmony and

counterpoint, and notions of abstract, context-free art. Crucial here is that Truax's engagement with technologies, first at the Institute of Sonology in The Hague, and later in his own work on the DMX-1000, led him to these positions. They required engagement with the challenges of signal processing and the models of sound and music upon which it operated.

Other scholars have already well documented Truax's DMX-1000-based system for *Riverrun* (see Clarke, Dufeu, & Manning, 2014), but a few salient features are worth noting here. Although at the processing level, Truax talks about fairly traditional concepts for sound synthesis like attack and decay (envelope), central frequency and frequency range, and delay time (1988, p. 17), his system allows for their real-time production on (at that time) unprecedentedly small timescales: 10–20 milliseconds. Working with these tiny events required a different approach to controlling them, since thousands of grains might occur in a single second. Using a command-line interface, Truax developed a set of procedures: presets, which specify states of the various parameters of sound for each grain or groups of grains; ramps, which are "patterns of change in the parameters at a specific rate" that can be initiated at specific times by the user; and tendency masks, which combine presets and ramps but appear as graphical control shapes to the user "and hence suggest a different compositional approach." The key to using these techniques, writes Truax, is to abandon the hope for a deterministic result (the way an orchestra composer might predict the outcome of a score) and instead engage with the program's sound-generating capability *processurally* (pp. 19–20). Today, such an approach to signal processing software would be unremarkable—it is a standard feature of everything, from digital audio workstations, to software synthesizers, to apps, to audio hardware. But it was not the dominant paradigm of working with digital sound for composers in the 1980s, and Truax's mode of thought showed how approaching sound from a granular perspective implied a different kind of relationship to creativity, control, and sonority.

In combining theory, processing and an interface, Truax's approach to sound was not abnormal for computer music at the time (as a brief read of computer music publications would show). But it is worth meditating upon his specific approach because it proposed a radical alternative theory of sound and mediation—sound as a particle, rather than a wave—and because it did so through the process of building and using a technology and a set of techniques. Anne Balsamo's (2011) approach to "designing

culture" argues that all technological artifacts are both technical and cultural and that technical experimentation thus also works as a form of cultural experimentation. Her concept of "hermeneutic reverse-engineering" is crucial here, because it combines the interpretative work usually associated with humanists ("hermeneutics") and the more mechanical study undertaken in engineering contexts to argue for a hybrid process (pp. 11, 14–16). Similarly, Matt Ratto uses the slightly awkward term "critical making" to signal a desire to "combine two modes of engagement with the world that are often held separate—critical thinking, typically understood as conceptually and linguistically based, and physical 'making,' goal-based material work" (2011, p. 253). As Ratto explains, the difference between his approach and the more traditional design- and engineering-based approaches to fabrication lies in that "Our main focus is on the act of shared construction itself as an activity and a site for enhancing and extending conceptual understandings of critical sociotechnical issues" (p. 254).

Obviously, Truax understood his project as primarily compositional, rather than humanistic or social scientific. Indeed, when I visited him at SFU in 2013, Truax told me he doesn't normally consider his work on acoustic ecology and his compositional and computational work to be connected. Yet they can clearly be read as intertwined, from the environmental themes of works like *Riverrun* and *Pacific* to the broader questions about the inner workings of sound raised by the technique of granular sampling and synthesis on which it is based, as well as his critique of composers' unwillingness to clearly and even didactically deal with real-world issues: "Unfortunately, people in computer music do not seem to have the same kind of broader concerns for social issues or the media, or if they do they don't see these are related to their professional work. For the most part composers seem wedded to abstract music […]. Their work doesn't influence the environment and they don't let the environment influence their music" (Iwatake & Truax, 1994, p. 20; see also Truax, 1992, pp. 38–40). Truax's work with *Riverrun* led to the shaping of techniques and practices that would be central to his approach to sound recordings drawn from the real world. If one can hear the ebb and flow of a river through granulated sine wave and FM particles, one is prepared to hear the sonic worlds inside a single phoneme, or in recordings drawn from around Vancouver. Through its temporal expansions and superpositions, *Riverrun*—and the processing, theory, and parameters behind it—announces the pluritemporality of sound and then becomes a field of play for sound and time. Truax was not the first person to notice this possibility, not by decades. But he provided a vital and lasting framework

to engage with sound and time as separable phenomena in real time, and a tool for others to use in their studies. That is what a good media theory does.

Conclusion: The WSP as an Archive of Sonic Practices

Decades before the term *digital humanities* was coined in 2001 (Kirschenbaum, 2010), and while English and other humanities departments were having debates about incorporating computers into their work, the World Soundscape Project was experimenting with combining humanistic modes of knowledge with media production and with alternative forms of knowledge dissemination. In this way, they were far ahead of their time and now provide an important sonic precursor to today's digital humanities. In mainstream academic publication and pedagogy, until recently presenting recorded sound with written scholarship was both difficult to achieve and rare. Books accompanied by compact discs were available from the 1990s, but the CDs were often lost, or, conversely, never played. They required too much coordination on the part of the user. Outside music schools, and sometimes in them, many classrooms had limited facilities for audio playback, an issue that surprisingly plagues us even today, as even sound-based panels and conferences sometimes have to work extra hard to have the most basic audio playback technology despite the ready availability of display technologies for slideware. There were novelties, like Marshall McLuhan's *Medium is the Massage* record, but these were exception that proved the rule. McLuhan's own involvement in the record was quite limited: he recorded his voice parts before creative director Jerome Agel and producer John Simon assembled the rest of the sound work.

Platforms that allow easy commingling of text and sound could and should have a profound effect on how we deal with sound in the humanities, now that it is more available to us in textual form. It is therefore useful to go back and think through how arguments have been rendered sonically in the past. Through my discussions of just two signature works from people involved with it, I have shown how the World Soundscape Project's body of sonic practice provides a rich repository of attempts to think sonically through sound and use audio as a tool for teaching theories of sound, culture, and media.

Long before the digital humanities came into focus as a field of practices, we can find people and practices who used analog media to accom-

plish some of the same things. One possible reading of Westerkamp's work would be rendered in terms of sound studies pride, to claim that "we were doing it first." But such a claim would have to leave aside traditions of filmmaking in visual anthropology, experiments with audio and video at the Media Education Foundation, and several other precursors. Instead, the takeaway should be that multimodal scholarship, teaching, and knowledge production are not so much about the technical tools the scholars use (despite the "multimodality" in the name) but rather the epistemologies and techniques of scholarly inquiry and argument that scholars can mobilize. The theoretical work of media production is most effective when, in beholding it, we focus more on the ideas and less on the tools or the methods that get us to those ideas, unless the theory is about the tools, as it was in *Kits Beach Soundwalk*.

Freeing ourselves to use new approaches and tools is a great and laudable goal, but we must also remember that new techniques of production always require new hermeneutics and appropriate modes of circulation and dissemination. This is common in writing but still rare in how humanists engage with multimodal work. Years of learning to read turn into comprehension of difficult texts; years of difficult reading and research lead us to advance new and challenging ideas. The same challenge now faces those scholars who are working in new modalities. If one of the goals of a fully realized sonic humanities is a fully realized sonic mode of scholarship, it will require that we sound in the idioms that our audiences are ready to hear or that we get our audiences ready to hear in the idioms in which we sound. Hildegard Westerkamp, Barry Truax, and even R. Murray Schafer understood this already in the 1970s, which is why they wrote, sounded, and taught in combination with one another. Their experiments are very much of their time and place, but they remain instructive for us today.

Notes

1. Thanks to the editors for the opportunity and their patience; to Carrie Rentschler, Andy Stuhl, and Rachel Bergmann for readings of a draft; to Mara Mills for many hours of rich conversation about sound, media, and time; to Tara McPherson for an opportunity to really think through sound and the digital humanities; to Neil Verma and Jake Smith and the SSLG at Northwestern University for a place to be heard; to Andra McCartney for

some helpful exchanges about the WSP; and to Barry Truax and Hildegard Westerkamp for talking with me and for their work.

2. At the risk of ruining the joke by explaining it for nonnative speakers, or for readers who stumble across this work in the future: "O.G." is a slang term from hip hop, short for "original gangsta," which refers to practice that is authentic, "old school," or the basis of something that others developed upon.
3. As of this writing, the piece is currently available to hear at https://www.youtube.com/watch?v=hg96nU6ltLk. It is also available on Westerkamp's *Transformations* CD.
4. This is not strictly correct. Andra McCartney (1999, p. 217) discusses score for the spoken part of the piece. NB: the digital copy of McCartney's dissertation lacks on-page pagination. Thus, I have cited the pages as displayed in a PDF reader so they are easier to find, even though they clearly do not conform to the original pagination for the paper document as suggested by the Table of Contents. I am using this copy: http://hildegard-westerkamp.ca/resources/PDFs/writings-pdf/Andradiss.pdf
5. From a definitional standpoint, Rutherford-Johnson is certainly correct, though from the standpoint of practice, the institutions of Western Art Music are still relatively *im*permeable for a wide swath of people and practices and remain overwhelmingly male (Born & Devine 2015). One hopes a new generation of composers, with ears for soundscapes, sound art, pop, funk, metal, and electronic music, might change this.
6. I am certain the company would hate this decidedly uncool comparison, but it illustrates Live's ubiquity in electronic music and sound art settings. In my experience, Live is a deeper and more engaging program in terms of its creative potential. That said, its "clip view" is sort of like an audio slide deck, where sounds can be played in sequence, in sync with one another, or—and this is where it far surpasses slideware—out of sequence.
7. I discuss the line from Truax's granular synthesis and sampling to modern software applications like Live more fully in a book I am currently co-writing with Mara Mills, entitled *Tuning Time: Histories of Sound and Speed*.
8. The earliest version of these technologies was developed in the 1930s and 1940s, using magnetic tape and optical sound-on-film technologies, so it is not an inherently digital process.
9. Wavelet synthesis works on an analogous principle (see, e.g., Kronland-Martinet, Morlet, & Grossman, 1987).
10. As of this writing, it is currently available online at https://www.youtube.com/watch?v=u81IGEFt7dM
11. This is my reconstruction of it from notes taken at the time, then turned into an account a few hours after the fact and edited here.

References

Akiyama, M. (2010). Transparent Listening: Soundscape Composition's Objects of Study. *RACAR, 35*(1), 54–62.

Balsamo, A. (2011). *Designing Culture: The Technological Imagination at Work*. Durham, NC: Duke University Press.

Blake, A. (2010). An Audible Sense of Order: Race, Fear and CB Radio on Los Angeles Freeways in the 1970s. In D. Suisman & S. Strasser (Eds.), *Sound in the Age of Mechanical Reproduction* (pp. 159–180). Philadelphia: University of Pennsylvania Press.

Born, G. (1995). *Rationalizing Culture: IRCAM, Boulez and the Institutionalization of the Musical Avant-Garde*. Berkeley, CA: University of California Press.

Born, G., & Devine, K. (2015). Music Technology, Gender and Class: Digitization, Educational and Social Change in Britain. *Twentieth-Century Music, 12*(2), 135–172.

Bouchard, A. (2009). *CEC — eContact! 11.2 — Granular Synthesis and Barry Truax's Riverrun*. Retrieved December 14, 2018, from https://econtact.ca/11_2/bouchard_truax.html

Brackett, D. (2016). *Categorizing Sound: Genre and Twentieth-Century Popular Music*. Berkeley, CA: University of California Press.

Chion, M. (1994). Audio-Vision: Sound on Screen. New York, NY: Columbia University Press.

Chun, W. H. K. (2011). *Programmed Visions: Software and Memory*. Cambridge, MA: MIT Press.

Clarke, M., Dufeu, F., & Manning, P. (2014, June). Barry Truax Riverrun (1986/2004), a Case Study for the Tacem Project, Exploring New Approaches to Techniques of Analysis and Re-Synthesis in the Study of Concert Electronic Works. *Proceedings Presented at the Electroacoustic Music Studies Network Conference*, Berlin. Retrieved from https://pdfs.semanticscholar.org/a33e/5a5686576788304aeeabb7f2c5565629a8ff.pdf

Curran, M. (2010–2018). *The Market*. https://themarket.blog

Deleuze, G. (2001). *Cinema 1: The Movement Image* (H. Tomlinson & B. Habberjam, Trans.). New York: Continuum.

Dyson, F. (2009). *Sounding New Media: Immersion and Embodiment in the Arts and Culture*. Berkeley, CA: University of California Press.

Eidsheim, N. S. (2015). *Sensing Sound: Singing and Listening as Vibrational Practice*. Durham, NC: Duke University Press.

Ernst, W. (2016). *Sonic Time Machines*. Amsterdam: University of Amerstdam Press.

Feaster, P. (2011). "A Compass of Extraordinary Range": The Forgotten Origins of Phonomanipulation. *ARSC Journal, 42*(2), 163–203.

Freire, A. M. (2008). Remediating Radio: Audio Streaming, Music Recommendation and the Discourse of Radioness. *Radio Journal, 5*(2–3), 97–112.

Gabor, D. (1946). Theory of Communication. *Journal of the Institute of Electrical Engineers, 93*(3), 429–441.

Gabor, D. (1947). Acoustical Quanta and the Theory of Hearing. *Nature, 159*, 591–594.

Galloway, A. (2012). *The Interface Effect*. Cambridge, UK: Polity.

Gitelman, L. (2006). *Always Already New: Media, History and the Data of Culture*. Cambridge, MA: MIT Press.

Gopinath, S. (2013). *The Ringtone Dialectic: Economy and Cultural Form*. Cambridge, MA: MIT Press.

Hayles, N. K. (2012). *How We Think: Digital Media and Contemporary Technogenesis*. Chicago: University of Chicago Press.

Hui, A. (2013). *The Psychophysical Ear: Musical Experiments, Experimental Sounds, 1840–1910*. Cambridge, MA: MIT Press.

Iwatake, T., & Truax, B. (1994). An Interview with Barry Truax. *Computer Music Journal, 18*(3), 17–24.

Kahn, D. (2013). *Earth Sound Earth Signal: Energies and Earth Magnitude in the Arts*. Berkeley, CA: University of California Press.

Kelly, C. (2009). *Cracked Media: The Sound of Malfunction*. Cambridge, MA: MIT Press.

Kim-Cohen, S. (2018, June). *Dark Optimism/Bright Pessimism: Listening Through Neoliberalism*. Presented at "Spectres de l'audible: Sound studies, cultures de l'écoute et arts sonores", Paris.

Kirschenbaum, M. (2010). What Is Digital Humanities and What's It Doing in English Departments. *ADE Bulletin, 150*, 55–61.

Kittler, F. (1999). *Gramophone-Film-Typewriter* (G. Winthrop-Young, Trans.). Stanford, CA: Stanford University Press.

Kittler, F. (2017). Real Time Analysis, Time Axis Manipulation. *Cultural Politics, 13*(1), 1–18.

Knouf, N. A. (2016). *How Noise Matters to Finance*. Minneapolis, MN: University of Minnesota Press.

Krämer, S. (2006). The Cultural Techniques of Time Axis Manipulation. *Theory, Culture and Society, 23*(7–8), 93–109.

Kronland-Martinet, R., Morlet, J., & Grossmann, A. (1987). Analysis of sound patterns through wavelet transforms. *International Journal of Pattern Recognition and Artificial Intelligence, 1*(2), 273–302. doi:10.1142/s0218001487000205.

Labelle, B. (2015). *Background Noise: Perspectives on Sound Art* (2nd ed.). New York: Continuum.

Leslie, M. (1970). In Defence of Anachronism. *Political Studies, 18*(4), 433–447.

Lingold, M. C., Mueller, D., & Trettien, W. (Eds.). (2018). *Digital Sound Studies*. Durham, NC: Duke University Press.
McCartney, A. (1998). Soundwalk in the Park with Hildegard Westerkamp. *Musicworks, 72*, 6–15.
McCartney, A. (1999). *Sounding Places: Situated Conversations Through the Soundscape Compositions of Hildegard Westerkamp*. PhD Dissertation, York University, Toronto.
McPherson, T. (2009). Introduction: Media Studies and the Digital Humanities. *Cinema Journal, 48*(2), 119–123.
McPherson, T. (2018). *Feminist in a Software Lab: Difference + Design*. Cambridge, MA: Harvard University Press.
Morris, J. W. (2015). *Selling Digital Music, Formatting Culture*. Berkeley, CA: University of California Press.
Nelson, A. J. (2015). *The Sound of Innovation: Stanford and the Computer Music Revolution*. Cambridge, MA: MIT Press.
Peirce, C. S. (1955). *Philosophical Writings of Peirce*. New York: Dover Publications.
Pohlmann, K. C. (2011). *Principles of digital audio*. New York: McGraw-Hill.
Radovac, L. (2015). Muting Dissent: New York City's Sound Device Ordinance and the Liberalization of the Public Sphere. *Radical History Review, 2015*(121), 32–50.
Ratto, M. (2011). Critical Making: Conceptual and Material Studies in Technology and Social Life. *The Information Society, 27*(4), 252–260.
Rée, J. (1991). The Vanity of Historicism. *New Literary History, 22*(4), 961–983.
Roads, C. (1988). Introduction to Granular Synthesis. *Computer Music Journal, 12*(2), 11–13.
Roads, C. (2004). *Microsound*. Cambridge, MA: MIT Press.
Rodgers, T. (2011a). "What, For Me, Constitutes Life in a Sound?": Electronic Sounds as Lively and Differentiated Individuals. *American Quarterly, 63*(3), 509–530.
Rodgers, T. (2011b). *Synthesizing Sound: Metaphor in Audio-Technical Discourse and Synthesis History*. PhD Dissertation, McGill University, Montreal.
Rutherford-Johnson, T. (2017). *Music After the Fall: Modern Composition and Culture Since 1989*. Berkeley, CA: University of California Press.
Schafer, R. M. (1967). *Ear Cleaning: Notes for an Experimental Music Course*. Toronto, Canada: Clark & Cruickshank.
Schafer, R. M. (1994). *The Soundscape: Our Sonic Environment and the Tuning of the World*. Rochester, VT: Destiny Books. Originally published as *The Tuning of the World*. New York, NY: Knopf, 1977.
Stanyek, J., & Piekut, B. (2010). Deadness: Technologies of the Intermundane. *The Drama Review, 54*(1), 14–38.
Sterne, J. (2003). *The Audible Past: Cultural Origins of Sound Reproduction*. Durham, NC: Duke University Press.

Sterne, J. (2012). *MP3: The Meaning of a Format*. Durham, NC: Duke University Press.
Sterne, J. (2015). The Example: Some Historical Considerations. In D. T. Goldberg & P. Svensson (Eds.), *Between the Humanities and the Digital* (pp. 17–33). Cambridge, MA: MIT Press.
Thompson, E. (2002). *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America 1900–1930*. Cambridge, MA: MIT Press.
Trammell, A., Stoever, J. L., & Silva, L. (2018). The Pleasure (Is) Principle: Sounding Out! and the Digitizing of Community. In M. C. Lingold, D. Mueller, & W. Trettien (Eds.), *Digital Sound Studies* (pp. 83–119). Durham, NC: Duke University Press.
Truax, B. (1988). Real-Time Granular Synthesis with a Digital Signal Processor. *Computer Music Journal, 12*(2), 14–26.
Truax, B. (1990). Composing with Real-Time Granular Sound. *Perspectives of New Music, 28*(2), 120–134.
Truax, B. (1991). Capturing Musical Knowledge in Software Systems. *Interface, 20*(3–4), 217–233.
Truax, B. (1992). Musical Creativity and Complexity at the Threshold of the 21st-Century. *Interface-Journal of New Music Research, 21*(1), 29–42.
Westerkamp, H. (1988). *Listening and Soundmaking: A Case Study of Music-As-Environment*. MA Thesis, Simon Fraser University, Vancouver.
Westerkamp, H. (1989). Kits Beach Soundwalk (audio recording). *Transformations*. Montreal: Empreintes DIGITALes, IMED 9631/1996.
Westerkamp, H. (1994). The Soundscape on Radio. In D. Augaitis & D. Lander (Eds.), *Radio Rethink: Art, Sound and Transmission* (pp. 87–94). Banff, AB: Walter Phillips Gallery.
Westerkamp, H. (2007). Soundwalking. In A. Carlyle (Ed.), *Autumn Leaves: Sound and the Environment in Artistic Practice*. Paris: Double Entendre. Retrieved from https://www.sfu.ca/~westerka/writings%20page/articles%20pages/soundwalking.html
Westerkamp, H. (2010). *What's in a Soundwalk?* Public Lecture Presented at the Sonic Acts XIII, Amsterdam.
White, H. (1966). The Burden of History. *History and Theory, 5*(2), 111–134.
Xenakis, I. (1992). *Formalized Music: Thought and Mathematics in Music* (Rev. ed.). Hillsdale, NY: Pendragon Press.