

Colloquy

Discrete/Continuous: Music and Media Theory after Kittler

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Introduction

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At first blush, the pair discrete/continuous seems to take us far from the concerns of musicology and place us firmly in the realm of statistics, data analysis, and number crunching. Put graphically, “discrete data” translates into dots or interrupted lines, while “continuous data” implies a curve. This would mean counting and measuring—how can these activities be relevant to music?

Our initial association might be with computers, but it is not necessary to invoke that squishy entity called the “digital humanities” here.¹ We fare better if we think of the discrete/continuous pair in the context of a different and seemingly outmoded approach to music aesthetics. Going back in time, beyond the influential Kantian tradition, we return to Gottfried Wilhelm Leibniz (1646–1716) of almost a century earlier, the great rationalist and

1. For a media archaeology of the digital, see Siegert's magisterial *Passage des Digitalen*.

mathematician who invented calculus from his Hanover home at the same time as Newton in Cambridge. Leibniz understood music as a sensory quality that is apprehended by the rational faculty. For him “rational” always meant one thing: counting. He famously defined music as “a hidden arithmetic exercise of the soul, which is unaware of its own counting.”² Kant and Schopenhauer toyed with Leibniz’s definition in their writings on aesthetics, but both eventually dismissed it (for different reasons).³ If Leibniz’s counting soul seems a strange way to think about music, then it is because we have forgotten it as other aesthetic issues have become more pressing, notably the work-concept and the genius composer. Yet there is much to be (re)gained from this Leibnizian universe.

Leibniz uses, first of all, a different lens for understanding music: instead of considering the compositional perspective, in which the musical material is shaped into themes, motives, and voices, he is far more concerned with the principles from which music emerges. In other words, his is an aesthetics of sound rather than of composed music. This perspective is closer to the Greek term “aisthesis,” or perception, which is, after all, the meaning that Alexander Baumgarten had in mind when he coined the term “aesthetics” in 1750—a term, and a time, in every sense halfway between Leibniz and Kant.

The return to Leibniz and the arithmetic paradigm, *mathesis universalis*, at the beginning of the twenty-first century is a well-calculated move. To be sure, numbers have always been around us: a fairly direct line could be drawn from Leibniz via Joseph Fourier (of “Fourier transform” fame, 1768–1830) to electronic music. The reconsideration of this older approach, however, would not make sense without the explicit realization that our own time is progressively dominated by numbers. The digital realm knows only zeros and ones, and out of these a whole universe can be created—in words, images, or sounds.

Poststructuralist Media Theory

The landscape of media studies is often divided, for better or worse, along broad linguistic groups centered on anglophone, French, and German traditions.⁴ The thinkers usually grouped together under the somewhat misleading label “German media theory,” whose best-known representative is the late Friedrich Kittler (1943–2011), are central here, since they have invested a great deal of energy in showing that this world of the machine is not exactly

2. Leibniz, letter to Christian Goldbach of April 17, 1712, quoted in Guhrauer, *Nachträge*, 66: “Musica est exercitium arithmeticae occultum nescientis se numerare anim[ae]” (the translations in this essay are mine unless otherwise indicated). See also Leisinger, *Leibniz-Reflexe*, 43–58.

3. See Kittler, “Musik als Medium.”

4. Notwithstanding powerful critiques, the Canadian school around McLuhan and Innis occupies a central position in the English-speaking world. In France, Derrida, Baudrillard, and Virilio must be mentioned.

new; we have just forgotten its mechanisms over the course of the last few centuries, essentially since the rise of humanism. Humanism has been a *bête noire*, or at best something of a distraction, for many media theorists—Kittler would habitually sneer at “so-called man.” This profound antihumanism was part of a wider program to drive the Hegelian spirit out of the humanities and move them outside the traditional confines of literary hermeneutics.⁵ Instead, Kittler pursued what others have called the “materialities of communication,”⁶ with a rigorous focus on technology. (He is often criticized for his insistence that entertainment technology, including sound media, is nothing but a waste product of the military industry. He considered warfare to be the main force of technological innovation.) For Kittler, the only things that have actual existence are data streams. A technophile who never met a hyperbole he did not like, he put it more strongly: “Only that which is switchable exists.”⁷ Kittler’s creed is an ontology of circuitry.

The basic principles on which Kittler’s media theory builds could not be simpler: data goes in, gets processed, and comes out. Or, in slightly more technical language, a medium is defined by three criteria: selection, storage, transmission. This model is enormously flexible, and it allowed Kittler to consider such disparate things as typewriters, the medieval university, and the city. But sound media have played, perhaps surprisingly, a privileged role in this model. Many musicologists will be familiar with Kittler’s work on the gramophone, which fueled a preexisting interest in recording media in musicology.⁸ Kittler argues that conventional musical notation systems, which store, process, and reproduce the notes of the chromatic scale, effectively act as a filter that prevents noise, wrong notes, extraneous sounds—in a word, nonsense—from entering into circulation. The gramophone, by contrast, has no such filter mechanism. It records the sound wave, warts and all. Neither quality nor intended meaning makes a difference to the recording. Sound is recorded *qua* sound.

The gramophone, in short, is a very different *Aufschreibesystem* from diastematic notation. “Aufschreibesystem” is usually rendered as “discourse network” but it translates more concretely as “writing-down system.” Kittler’s late work, less well known in English-speaking countries, takes an even broader

5. Kittler entered the academic stage with an edited collection bearing the pugnacious title *Die Austreibung des Geistes aus den Geisteswissenschaften* (1980), a pun that can hardly be translated into English but that promises to exorcise the (Hegelian) spirit/ghost from the humanities (“sciences of the spirit”). Using the same take-no-prisoners approach, he was part of the first generation of German scholars to promote ideas by French poststructuralists, above all Foucault, Derrida, and Lacan, in sharp opposition to the hermeneutic tradition stemming from Gadamer, Dilthey, and Schleiermacher that was prevalent in German literary study.

6. Gumbrecht and Pfeiffer, *Materialities of Communication*.

7. Kittler, *Draculas Vermächtnis*, 182: “Nur was schaltbar ist, ist überhaupt.”

8. Kittler, *Gramophone, Film, Typewriter*. Some implications for musicological discourse are explored in Rehding, “Wax Cylinder Revolutions.”

notion of *Aufschreibesysteme*—going all the way back to the vowel alphabet in ancient Greek.⁹ The Greeks adopted the Phoenician alphabet, but tweaked it to suit their needs, most importantly adding vowels. Whereas the Phoenician *'alep* signifies a glottal stop, the Greek alpha, for the first time in history, allowed us to write down the vowel “a.” This made Greek the first language that anyone could read out aloud, even without understanding its meaning. In Greek it became possible to write down place names such as Circe’s island Aiaia, which would elicit only blank stares if we tried to mark it on a map using older, vowelless alphabets. What is more, the Greeks used their letters to write down words, as well as numbers and music. Alpha to theta represented 1–9, iota to koppa the decimals 10–90, and finally rho to sampi the hundreds.¹⁰ As for music, certainly vocal music, letters could simply be written above the syllables of a poem, to indicate the pitches at which it should be sung. In the Greek *Aufschreibesystem* it was possible, at least in principle, to sing numbers, to count up names, or to pronounce melodies.

The vowel alphabet has itself been likened to a gramophone, storing and reproducing sounds.¹¹ When viewed in this way the data streams of the ancient Greeks look much like those of the modern digital world, in which the same innocuous mix of zeros and ones can be made to serve any sensory domain—whether image, sound, or words. To the indifferent computer these are nothing but data streams.

After Kittler

When Kittler died—or rather, transfigured—in 2011, it was with a characteristically theatrical air: “Alle Apparate aus[s]chalten” (Switch off all the machines).¹² His dying words demonstrated, if any such demonstration were necessary, that he was dead serious about his ontology of switchability. His followers and colleagues took a number of his ideas even further and exploded the notion of media and discourse networks in multiple directions, resulting in what some have likened to a quasi-Hegelian split into “left-Kittlerians” and “right-Kittlerians.”¹³ On the one hand, Sybille Krämer’s and Bernhard Siegert’s explorations of “cultural techniques” expand notions of the kinds of operation that might constitute mediality, which allows the human to reenter

9. Kittler began a ten-volume series, *Musik und Mathematik*, which was to extend from ancient Greece to the Turing Galaxy, only the first two volumes of which were published.

10. Numbers are based on the archaic alphabet, which included a few letters that later fell out of use.

11. See Ernst and Kittler, *Die Geburt des Vokalalphabets*.

12. See Tom McCarthy, “Kittler and the Sirens,” *London Review of Books Blog*, November 9, 2011, accessed February 19, 2016, <http://www.lrb.co.uk/blog/2011/11/09/tom-mccarthy/kittler-and-the-sirens/>.

13. See Winthrop-Young, “Cultural Techniques,” 15.

the discussion.¹⁴ One cornerstone of “cultural techniques” is an ontological reversal whereby activities such as counting *precede* the associated concepts such as number, normally thought to come first. On the other hand, scholars such as Wolfgang Ernst and Jussi Parikka pursue a “media archaeology,” writ large, that is to a great extent concerned with sound and sonic histories.¹⁵ Always interested in nonlinear narratives, media archaeologies such as Siegfried Zielinski’s “variantology” have pushed particularly toward a less canonical and less Eurocentric understanding of *where* media histories lie.¹⁶

To put the difference between the two main groups as succinctly as possible, Kittler’s media became practices in the hands of the proponents of cultural techniques, whereas the media archaeologists homed in on object-centered epistemologies. These media approaches offer enormous possibilities for musicology, broadly conceived, not least as their focus and questions sharpen the view for a perspective that is often thought to be incidental to music. From a media-theoretical perspective, the question of whether sounds are stored in the magnetic charges of a cassette tape, binary code, a music box, or indeed the muscle memory of a pianist is of central significance. Media archaeology argues that the medium is not merely a vehicle that is somehow external to music but is rather inextricably connected with it: the sounds exist only in and by virtue of the medium. And the study of cultural techniques explores seemingly mundane activities—pointing, flattening, grid-making—from the perspective of their medial import. (To take but one example here, the Guidonian hand is the embodiment of a long-standing cultural technique.)¹⁷ According to either of these approaches, textual, analog, and digital forms of inscription constitute entirely different worlds.

Media Archaeology

The statement “In the beginning was the wheel” is one that media archaeologists could get excited about. Specifically, a “Savart’s wheel”: take a stiff piece of cardboard, such as a beverage coaster, hold it between the spokes of a bicycle, and turn the wheel. The vibrating coaster will make a sound, its pitch rising as the wheel turns faster. This staple of the scientific demonstration cabinet has a more complicated history than is suggested by its name (which refers to the French physicist Félix Savart, 1791–1841). It was invented over and over again, starting—probably—with Robert Hooke (1635–1703). Its importance is hard to overestimate, its experimental design demonstrating, visually and aurally, the correlation between frequency and

14. See, for example, Krämer and Bredekamp, *Bild—Schrift—Zahl*, and Siegert, *Cultural Techniques*.

15. See, for example, Ernst, *Digital Memory and Sonic Time Machines*; Parikka, *What Is Media Archaeology?*; and Huhtamo and Parikka, *Media Archaeology*.

16. See, for example, Zielinski, *Deep Time*.

17. See Wenzel, “Von der Gotteshand.”

pitch. On the basis of the number of teeth on the cog and its rotation speed, we can calculate how many times the cog strikes per second to produce a given pitch.¹⁸ Clearly excited about his idea, Hooke also told his friend Samuel Pepys that he would be able to identify the buzz of a fly by counting the frequency at which it flapped its wings.¹⁹

From a musical perspective Hooke's wheel was overshadowed by the invention of the tuning fork only a few decades later. But for a media archaeologist, the wheel, which lays bare the underlying mechanics, has great advantages over the tuning fork. It allows us to "reverse-engineer" the mechanism of sound generation. The central question of media archaeology, "How does it work?," erects its epistemology on the material objects it studies.²⁰ Naturally, the wheel presents the primal scene of discrete sound generation, which returns us to our main focus. Suddenly we are quite close to Leibniz's counting soul.

Cultural Techniques

"In the beginning was the deed." The hypothesis on yodeling of Carl Stumpf (1848–1936) makes for a striking example of a cultural technique in the sound world. Stumpf regards music essentially as a technique that serves vocal communication. In trying to convey information across distances, he argues, it is useful for the voice to linger "on a high, fixed pitch at great volume—as produced naturally simply by the greatest tension of the vocal folds."²¹ As the lung volume depletes, the pitch sometimes descends, he further observes, and the sound gains in volume when multiple voices come together. Having deduced music from these calls across mountains, Stumpf extrapolates the emergence of specific musical features that the early twentieth century considered essential to music. Octaves and fifths occur, he explains, if men and women join together in the natural range of their voices. Ringing out strongly, these intervals "fuse" particularly well, which is how he explains the basis of consonance. Motives, he speculates, are easily recognizable signals, which require little data to produce clear signs ideal for calling specific people. From there it is just a small step to melodies, to responsories, and to contrapuntal techniques.²²

We need not worry about the veracity of Stumpf's whimsical hypothesis here. What matters is the idea that yodeling could be counted as a cultural technique in the sense that fire making, plowing, writing, or counting can be understood: as activities and practices that engender cultural products.²³ What

18. See Inwood, *Man Who Knew Too Much*, 223–25.

19. *Ibid.*, 73.

20. See Parikka, *What Is Media Archaeology?*

21. Stumpf, *Origins of Music*, 45.

22. *Ibid.*, 45–50.

23. See Krämer, "Cultural Techniques."

are the foundations on which culture is erected? The use of technologies in generating knowledge is central here. Writing has doubtless received the greatest attention, but it is hardly the exclusive cultural technique.

In reality there is no hard-and-fast boundary between media archaeology and cultural techniques. It would be possible, in principle, to conduct a media archaeology of yodeling and to examine the cultural technique of spinning Hooke's wheel. The contributions to this colloquy explore various intersections of music and media theory, offering perspectives that resonate with cultural techniques and/or media archaeology. Gundula Kreuzer probes Kittler's deep-seated fascination with Richard Wagner and links it to current concerns in opera studies. Peter McMurray draws on Wolfgang Ernst's idea that a medium can be both object and agent of its own archaeology, but in a move more common in cultural techniques he aims that analysis at the human body, including its potential for disability, and more specifically at the ear. Sybille Krämer returns to the era of *mathesis universalis* in her exploration of diagrammatics and epistemology in Descartes's work on music from the perspective of cultural techniques. And Roger Moseley scrutinizes Ernst's most recent writings on time-critical media—that is, media that *create* a sense of temporality. This is a concept with clear repercussions for music, and he finds surprising resonances with historically informed performance.

Further connecting points between the tenets articulated by media studies and the current interests of musicology are not difficult to find. The various strands within the burgeoning field of sound studies offer the most obvious affinities, but we need not stop there. Nicholas Mathew and Mary Ann Smart's "Quirk Historicism," "assembling and scrutinizing disparate objects, events, and documents,"²⁴ effortlessly ties in with media archaeology's fascination with forgotten, discarded, or imaginary media objects. And William Cheng's and Benjamin Piekut's adaptations of Bruno Latour's Actor Network Theory (ANT),²⁵ building on the agency of objects, are commensurable with media theory's "common denominator" that "media do not merely transmit data, but also—somehow—bring them forth."²⁶ Many other connections to ongoing musicological work are easily imaginable.

To round off our exploration of Leibnizian aesthetics and its afterlives, let us zoom in on the year 1843, a date that does not feature prominently in most conventional music histories but that marks a decisive moment from a media perspective, eclipsing even the invention of the gramophone later the same century. In 1843 Georg Simon Ohm transferred Fourier analysis

24. Mathew and Smart, "Elephants in the Music Room," 61.

25. Cheng, *Just Vibrations*, esp. ch. 2; Piekut, "Actor-Networks in Music History." See also Taruskin, "Agents and Causes."

26. Krämer, "Was haben 'Performativität,'" 23: "der kleinste gemeinsame Nenner"; "dass Medien das, was sie übertragen, zugleich auch—irgendwie—hervorbringen."

to the field of acoustics and made musical sounds legible, calculable, and measurable.²⁷ It was this turning point that allowed the sound wave to become the bedrock of musical thought. Musicology is only just beginning to evaluate the far-reaching consequences of this watershed, and media theory can help. Whether discrete or continuous, the task is, in Bernhard Siegert's words, to replace the Critique of Reason with a Critique of Media, which is always also a Critique of Culture.²⁸

Kittler's Wagner and Beyond

GUNDULA KREUZER

Alongside Alan Turing, Pink Floyd, and the military, Richard Wagner is a recurring trope in the work of Friedrich Kittler. Beginning in 1985, a crescendo of aphorisms established his fundamental claims about Wagner's role in media history, which in turn exemplified key aspects of Kittler's theory. A provocative aside in *Discourse Networks 1800/1900* cast the "Artwork of the Future" as nothing less than a "monomaniacal anticipation of the gramophone and the movies." *Gramophone, Film, Typewriter* ventured that Wagner, via Alberich's invisibility cap, had "invented the radio play." In an essay entirely devoted to Wagner, Kittler described music drama as "the first mass-medium in the modern sense of the word." And by 1988 he had hailed Wagner as the "founding hero" of special effects in entertainment electronics. Kittler's Wagner, in short, prefigured all twentieth-century "technical media."²⁹

Unlike frequent evocations of the *Gesamtkunstwerk* in accounts of virtual or multimedia art, Kittler's agenda was not to reveal that an ever more technologized world was both culturally rooted and historically mediated, conjuring Wagner for the sake of artistic legitimacy and aesthetic ancestry. Quite the opposite: he argued that it was Wagner who first effected the transformation of art into media. Wagner, Kittler wrote, pushed art from the previous symbolic order of representation toward data streams that "correlate in the real itself to the materiality they deal with"; even before Edison, Wagner had "invented the first artistic machine capable of reproducing sensuous data as such."³⁰ Kittler's Wagner, then, was an engineer. Or, having flipped the switch toward modern mass media, he became a technical catalyst himself.

27. Ohm, "Über die Definition des Tones." See particularly Ernst, *Sonic Time Machines*.

28. Siegert, *Cultural Techniques*, 1.

29. Kittler, *Discourse Networks*, 116; Kittler, *Gramophone, Film, Typewriter*, 104; Kittler, "World-Breath," 215; Kittler, "Signal-to-Noise Ratio," 173; Kittler, *Optical Media*, 40. On Kittler's McLuhanesque yet strictly deterministic concept of the "medium in the technical sense" more generally, see Kittler, *Optical Media*, 29–46.

30. Kittler, "World-Breath," 215–16.

Although Kittler resisted classification as a media archaeologist, his treatment of Wagner reveals an antiteleological (or noncontinuous) historiographical mode often associated with media-archaeological approaches and their tendency to read “traces of digital technologies into history, not the other way around.”³¹ Hence the frequent invocation of a medial *avant la lettre* by Kittler no less than by media archaeologists who took their cue from him. Divested of his usual operatic backdrop and placed among more mainstream figures in the history of technology, Wagner thus emerges as a discrete entity of prophetic and symbolic stature in Kittler’s declaredly anti-hermeneutic “media science.” And in order to retain the most hermeneutically discussed of composers in the position of media hero, Kittler swiftly bypassed then-customary preoccupations with semantically charged leitmotifs and with music as language. But why this seemingly paradoxical choice of chief “classical music object” by a literary scholar turning to the medial conditions of human expression? Put differently, what does Wagner do for Kittler—and what, in turn, does (or could) Kittler do for music scholars?³²

In search of answers, I will subject Kittler’s writings themselves to something like a cursory media-archaeological perspective. A good starting point is the triple move by which Kittler turned Wagnerian music drama into the first mass medium. Wagner, he held, dreamed up “a machine that works on three levels or in three data fields: first, verbal information; second, the invisible Bayreuth orchestra; third, the scenic visuality with its tracking shots and spotlights *avant la lettre*.”³³ We might ponder how this trifold division reflects—or inflects—the Lacanian orders of the symbolic, the real, and the imaginary that also inform other triads so beloved of Kittler (his joint discussion of gramophone, film, and typewriter being a prominent example), and what such a reading might bring to the conceptualization of sound and vision in opera. But Kittler’s Wagnerian trinity also chimes remarkably well with the concept of three “semiotic systems” that arose among Italian opera scholars around the same time, and that shaped the newly emerging “opera studies” of the 1990s and beyond.³⁴ Such ternary thinking helped to draw scholarly attention away from the philologically codified musical and textual levels to the less well-documented dimension of staging and all its component parts. Yet musicologists tended to conceive of these systems as hierarchically interdependent, looking at the ways each layer—from verse to music to staging—added semantic meaning. By contrast, Kittler focused on the “illiterate,” sensual multimedia experience, which he based on an initial separation of the three levels into non-signifying data streams. As he explicated in 1999, “If media technology must first isolate and incorporate individual sensory channels and then connect them

31. Lovink, “Archive Rumbblings,” 193.

32. For a different response to the latter question, see Klein, “Wagners Medientechnologie.”

33. Kittler, “World-Breath,” 232–33.

34. Thus particularly Della Seta, “O cieli azzurri,” 49–50.

together to form multimedia systems, then Wagner's Bayreuth opera was the first historical realization of this principle."³⁵

Yet this proto-cinematic audiovisual synthesis is less a technical account of music drama than of the Bayreuth Festspielhaus, no matter that only a few of Wagner's works premiered there. Such historical telescoping is owed on the one hand to Kittler's concern not with abstract artworks but with the experience of their realizations in the flesh, which is to say as media. On the other hand, the equation of Wagner with Bayreuth is one of those notoriously sweeping dicta with which Kittler, perennial *enfant terrible*, wiped clean the content-oriented German academic slate in order to highlight the latter's enabling materiality. In so doing Kittler evoked Wagner's own idiosyncratic historiographies: in their efforts to construct alternative genealogies for opera or technical media (together with their personal worldviews), both authors showed a predilection for broad historical strokes, polemical aphorisms, and counterintuitive associations. Did Wagner model *Kittlerdeutsch*?³⁶

More importantly, what Wagner did for Kittler was to build a theater. Uniquely among composers he thus devised technological hardware for the ideal operation of his operas (or software) that still functions more or less as it did at its inauguration in 1876. (The fact that Kittler downplayed Bayreuth's administrative and stage-technological changes underlines the importance of this continuity for his argument.) Indeed, the Bayreuth theater presents the iconic material object of archaeology. As such, to adopt words by Kittler's erstwhile Berlin colleague Wolfgang Ernst, it "undo[es] historical distance simply by being present."³⁷ And what this material presence did for Kittler was to demonstrate a mechanical isolation of hearing from seeing usually associated only with phonographic recording technologies. From this perspective, Wagner's most revolutionary deed was to make the orchestra invisible as a means of sound production, thereby giving it "the exact function of an amplifier" vis-à-vis the events of the drama. Sound, for Kittler, was thus both source and essence of music drama.³⁸

Of course, the concept of invisible sound is another hazardous shorthand. Think only of singers, whose sound production is by default displayed audiovisually. True, frustrated as he was by the deficiencies of his Bayreuth *Ring* production, Wagner briefly fantasized in 1878 about veiling his actors as

35. Kittler, *Optical Media*, 172.

36. The term is Geoffrey Winthrop-Young and Michael Wutz's, from their introduction to Kittler, *Gramophone, Film, Typewriter*, xxxii; see also Winthrop-Young, *Kittler and the Media*, 124–26.

37. Ernst, *Digital Memory*, 57.

38. Kittler, "World-Breath," 224. Richard Klein has argued that Wagner's crucial function for Kittler was to fill a historical gap between "Classical-Romantic literature and the technical media of the late nineteenth and twentieth centuries": Klein, "Wagners Medientechnologie," 413 ("klassisch-romantischen Literatur und den technischen Medien des späten 19. und 20. Jahrhunderts," my translation).

well.³⁹ What he could not carry out practically Kittler tackled rhetorically: he reduced singers to text-declaming throats (the operatic equivalent of “so-called man”) whose “output” is “fed into an amplifier named orchestra” and from there via a lightshow “into the nervous system of the audience.”⁴⁰ But this chain of medial amplifications—what the later Kittler would have called recursions—has no real-life equivalent in either the genesis or the performance of opera.⁴¹ Indeed, Wagner’s frustration points to the idealism underlying Kittler’s enterprise. For all his interest in obscure technologies, he dealt with their idea rather than their actual working (or otherwise)—the creaks and smells, say, of Wagner’s theater in operation. Ironically, given his emphasis on Bayreuth, Kittler’s approach is dematerialized. His Wagner is the PR campaigner of the 1863 preface to the *Ring* libretto and the 1870 “Beethoven” essay (that is, the Wagner of post-Schopenhauerian theorizing), not the exhausted Wagner of 1876 who realized all too late the short-comings of his dream-turned-brick-and-steel-reality. The analogy of “Wagner” and modern media technologies applies, then, to desired achievements or inner visions rather than to external correspondences. A composite of ideas, Wagner is synthesized into the Festspielhaus, whose historical discreteness simultaneously absorbs his works and exempts them from music-historical contexts. Kittler thus remains more beholden to German idealist Romanticism than he would have us believe.

This legacy is evident also in the very focus on Wagner, which reinscribes the composer’s self-made image of innovator. *Optical Media: Berlin Lectures, 1999*—Kittler’s most sustained historical argument on the development of technical media before his late turn to antiquity—shows Kittler wary of the risk “of falling under the spell of a cult of genius pioneers or inventors and so forgetting the quotidian aspects of the media industry once it is established.” But this risk is incurred not just by neglecting later “solutions to early problems”;⁴² it also looms by postulating originators in the first place. And media archaeology itself invites us to pose the following question: if Wagner “invented the radio play,” who invented Wagner’s music drama? Should there not also be a “Wagner *avant la lettre*”? Recent scholarship has, of course, begun to dig up the roots of the *Gesamtkunstwerk* notion in Romantic thought, and we have long known that Wagner built on inherited compositional, dramaturgical, and stage-practical techniques. But when Kittler writes of “acoustic effects replac[ing] the symbolic (i.e., written) structure of drama and music,” or of Wagner composing “the feedback of sound,” or of music “becom[ing] a matter of pure dynamics and pure acoustics,”⁴³ I can think of

39. See Wagner, *Cosima Wagner’s Diaries*, 2:154 (entry of September 23, 1878).

40. Kittler, “World-Breath,” 233.

41. On recursion, see Winthrop-Young, “Siren Recursions.”

42. Kittler, *Optical Media*, 34.

43. Kittler, “World-Breath,” 226, 224.

no more resonant an example than the Rossinian crescendo, where music amplifies nothing but itself. If we begin to listen to music as an acoustic data stream, we may well rehear pre-Wagnerian opera with proto-Wagnerian (or proto-proto-Kittlerian) ears.

Kittler's primary focus on sound rather than on notated music or Wagner's frequently hailed visual effects has indeed left traces in musicology. To be sure, it was itself inspired by Kittler's *bête noire* Theodor Adorno, with whom he shared his myopic fixation on Wagner. Key here was Adorno's somewhat begrudging claim that Wagner's true artistic "discovery" lay in the realm of orchestral color, or *Klang*. With his many instrumental doublings, Adorno reasoned, Wagner had veiled each instrument's distinct sound and created instead an objectified orchestral palette of *Mischklänge* that prefigured "the idea of an electrical continuum of all possible timbres." In terms of media archaeology, Adorno's Wagner anticipated the synthesizer. For Adorno this was a dubious step toward the commodified culture industry—"the victory of reification in instrumental practice."⁴⁴ For Kittler's technophilia, however, it was genius. And his exuberant acoustic turn helped to encourage a renewed musicological interest in timbre, as evinced in Tobias Janz's important study of Wagner's *Klangdramaturgie* or the recently burgeoning interest in orchestration and STS-based organology.⁴⁵ From here, and moving beyond Kittler's leveling of music and sound, Ernst has proposed another (implicitly Lacanian) trio: his triangulation between "the acoustic (physics), the sonic (cultural conditioning) and the musical (cultural semantics)"⁴⁶ further challenges inherited historical dualisms, such as those of tone and sound or music and noise, by sensitizing our ears to a variety of hitherto unexplored *intramedial* layers of sound that inform our physiological experience of music.

But there is yet more to mine in media archaeology's furrowed provocations. Kittler's idea of a mechanical Bayreuth, for instance, invites an understanding of Wagner's theater as recording technology proper: an apparatus to which he entrusted his desired "model performances," and whose continued functioning he hoped (in vain) to bolster with an artistic school in which "so-called man" would be drilled to reproduce his intentions perfectly and at will.⁴⁷ From this perspective Ernst's general claim that "[t]echnical repeatability leads to the option of an almost ahistorical functional reenactment"

44. Adorno, *In Search of Wagner*, 60, 67, 71. On Kittler's relative dependence on Adorno, see also Klein, "Wagners Medientechnologie," 410; on the synthesizer, see *ibid.*, 414.

45. Janz, *Klangdramaturgie*; see also, for instance, Dolan, *Orchestral Revolution*, and Tresch and Dolan, "Toward a New Organology."

46. Ernst, "From Media History to *Zeitkritik*," 141. See also Ernst, *Sonic Time Machines*, 24–25.

47. I explore this resonance further in my forthcoming book *Curtain, Gong, Steam: Wagnerian Technologies of Nineteenth-Century Opera*.

casts Bayreuth's early cult of ossified productions in the light of a theater carrying out its own archaeology.⁴⁸

More fundamentally, media archaeology's emphasis on the presentness of technical artifacts resonates intriguingly with music historiography. According to Ernst, not only do sonic media inhabit their own intrinsic temporal regime—their *Eigenzeit*—but media systems also defy historical time. As long as a device of the past (such as a 1940s radio transmitter) can still be operated today, “[t]here is no ‘historical’ difference in the functioning of the apparatus now compared to then . . . rather, there is a media-archaeological short circuit between otherwise historically clearly separated times.”⁴⁹ If we substitute “notated music” for “apparatus” we come close to Carl Dahlhaus's claim that “the aesthetic presence of individual works will necessarily intervene in any account of the past.” Dahlhaus considered this chronological disruption a central epistemological dilemma that led him to proclaim “the special nature of music historiography.”⁵⁰ But Ernst's project reminds us that “great” works (the object of Dahlhaus's concerns) are not so special in their defiance of linear history after all. Perhaps, then, a music archaeology could forge new paths between and beyond Dahlhaus's binary poles of musical works perceived either as timeless aesthetic utterances or as cultural-historical documents, while also mediating media-archaeological insistence on the *Eigenzeit* of sound objects with their inherent contextual contingencies. Historically discrete media *and* cultural artifacts might jointly be conceived as creating intersecting networks of crisscrossing historical continuities beyond chronological time. Such a perspective would interface the history of musical composition with a wider field of human invention,⁵¹ accounting for objects and processes, media and cultural techniques, men, music, and machines.

Meta-aurality: A History of Listening to Listening

PETER McMURRAY

In 2005 Native American composer Brent Michael Davids premiered a new piece entitled *Tinnitus Quartet*. Davids suffers from tinnitus; the piece is structured around a persistent high A that Davids hears in his right ear.

48. Ernst, *Digital Memory*, 175. On media carrying out their own archaeology, see also Peter McMurray's contribution to this colloquy.

49. Ernst, *Digital Memory*, 57. See also Ernst, *Sonic Time Machines*, 93–95.

50. Dahlhaus, *Foundations of Music History*, 3.

51. On media archaeology's affinities with organology, for instance, see Roger Moseley's contribution to this colloquy. In his most recent work Ernst himself has sounded out different resonances between musical practices and media-archaeological alternatives to historiography, on the basis of what he calls the inherent sonicity of media: Ernst, *Im Medium erklingt die Zeit*, esp. 211–19.

Dauids's piece fits into a long tradition of music by composers suffering from tinnitus. Most famously, Beethoven complained as early as 1800 of a "ringing and buzzing in my ears."⁵² Robert Schumann also described sounds he heard in his ears as "ceaseless ringing and musical sounds" and "the most terrifying sensation and a ceaselessly sounding, tormenting music."⁵³ In his later years, Schumann, like Dauids, apparently heard the note A persistently.⁵⁴ And in 1876 Bedřich Smetana would foreshadow Dauids's quartet by attempting to approximate the effects of tinnitus in his string quartet "From My Life." He explained, "The long insistent note in my finale [of the first movement] . . . is the fateful ringing in my ears of the high-pitched tones which, in 1874, announced the beginning of my deafness."⁵⁵ Many scholars are interrogating such issues through neuroscience and disability studies,⁵⁶ and all these biographical fragments raise a key question for media theory, too: what does it mean to listen to sounds that seem to be produced by the ear?

The same questions hold relevance for aurality more generally. What does it mean to listen to listening? What is the history of such a practice? How might it be done and what would it reveal? These questions point to a long span of ideas about tinnitus and other ways of listening to listening, as well as an attempt to conceive of a sound-native form of media archaeology—what I call "sonic archaeology." In particular, the human listening apparatus offers a key site for thinking about the possibilities and limitations of archaeology *through* and *by* sound and sound media. I consider such an archaeology here, focusing on two kinds of sounds produced and/or perceived by that apparatus: tinnitus and otoacoustic emissions.

The term "media archaeology," while neither coined nor even used by Friedrich Kittler, is closely associated with his poststructuralist, hardware-centric approach to media history.⁵⁷ But the concept of media archaeology is hardly self-elucidating. In the spirit of Wittgenstein, we might begin by interrogating it in terms of language: what is the relationship between the two terms "media" and "archaeology"? At first glance it would seem to be an archaeology *of* media—in the same way that one might write an archaeology of prisons, mental hospitals, or sexuality, like Foucault, or, more directly relevant, of the gramophone or the alphabet, like Kittler, or of "noise," like

52. Beethoven, *Beethoven's Letters*, 1:32.

53. Quoted in Sams, "Schumann's Hand Injury," 1158 ("das ewige Klingen und Musizieren"; "dem schrecklichsten Sinnen und ewig singender quälender Musik"). Translations in this essay are mine unless otherwise indicated.

54. See Sacks, *Musicophilia*, 51.

55. Quoted in Keller, *Chamber Music*, 451.

56. See, for example, Straus, *Extraordinary Measures*; Cheng, *Just Vibrations*; Bakan, "Don't Go Changing"; Mills, *On the Phone*; and Arbib, *Language, Music, and the Brain*.

57. See Parikka, *What Is Media Archaeology?*, 67–70.

Bernhard Siegert.⁵⁸ But the term could just as well denote archaeology *by* media, following Wolfgang Ernst's assertion that *media themselves* can be the archaeologists—that is, the operations and materiality of a given medium can themselves demonstrate the historical ruptures and surprising continuities of that medium and its usage. Ernst's paragon, the monochord, performs its own archaeology by demonstrating the basic physics of vibrating strings and the overtone series, whether played today or in the time of Pythagoras.⁵⁹

Following Ernst's lead we might turn to the ear and the human auditory system as a fleshy medium that can similarly serve not only as the site or object of archaeology but as the actor of archaeology itself. This possibility is already suggested in Mara Mills's history of cochlear implants.⁶⁰ Cochlear implants allow transduction to take place outside the ear, such that electrical signals are sent directly to the brain, resulting in a kind of "earless hearing." Tinnitus and otoacoustic emissions, while rooted in the auditory system itself, similarly challenge a notion of audition in which hearing is simply hearing—and nothing else. Instead, both tinnitus and otoacoustic emissions raise the issue of an ear that *produces* sound, whether psychoacoustically (as in most cases of tinnitus) or physiologically (as in the case of otoacoustic emissions), which in turn challenges us to understand hearing as some kind of media process of receiving, processing, and transmitting sensory data.

An Archaeology of/by/in the Ear: Tinnitus

The earliest accounts of ears that sound are to be found in Egyptian texts from the sixteenth century BCE dealing with "bewitched ear[s]."⁶¹ The library of the seventh-century-BCE Assyrian king Ashurbanipal at Nineveh, now held in the British Library, includes hundreds of cuneiform medical tablets. Many of these are devoted to remedies for diseases of the ears, especially a problem widely considered to be tinnitus: "If the hand of a ghost seizes on a man, and his ears sing . . ." The tablets then suggest a variety of treatments, ranging from making charms and stuffing them in the ears to fumigating the ear with various chemicals "by means of fire."⁶² Three different kinds of tinnitus appear in these tablets: ears that "sing," that "whisper," and that "speak," which may correspond to ringing tinnitus, hissing tinnitus, and perhaps auditory hallucinations.⁶³ Significantly, the cause of these ailments

58. Foucault, *Birth of the Clinic* and *Archaeology of Knowledge*; Kittler, *Gramophone, Film, Typewriter* and *Musik und Mathematik*, vol. 1; Siegert, "Cacography or Communication?"

59. Ernst, *Im Medium erklingt die Zeit*.

60. Mills, "Do Signals Have Politics?"

61. See Stephens, "Treatment of Tinnitus," 963.

62. See Thompson, "Assyrian Prescriptions," 1–6.

63. See Stephens, "Treatment of Tinnitus," 963–64.

is ascribed to the hand of a ghost, highlighting the (often) nonvisible etiology of tinnitus.

Greek and Latin medical writers, including Hippocrates and Galen, identified tinnitus—which is derived from the Latin “tinnire,” meaning “to ring”—as an explicitly medical disorder. In one of the more extended commentaries on the subject, Aulus Cornelius Celsus (first century CE) crucially introduces the ailment as “ubi aures intra se ipsas sonant”—“when the ears resound within themselves.”⁶⁴ The ears have a complex, multifunctional role here as both the agent/subject of the sounding or ringing ear (“aures sonant”) and also as the site of the action (“intra se ipsas”). The combination of the verb “sonant” (which can be intransitive or transitive) and the emphatic “ipsas” suggests an almost reflexive sense as well: the ears cause [the space] within the ears—that is, the ears themselves—to resonate. Sound of/by/in the ear: the ringing of tinnitus sets into motion a sonic archaeology with the ear as archaeologist.⁶⁵

Not long after Celsus’s death the Roman emperor Titus came to power after besieging Jerusalem and destroying the Second Temple. According to an account in the Babylonian Talmud, not present in any other Roman-era sources, Titus’s ears suffered from tinnitus as a form of divine punishment:

A gnat entered his nostril and pecked at his brain for seven years. One day Titus was passing by a blacksmith. He heard the noise of the sledgehammer and the gnat became silent. Titus thus said: “Here is the remedy.” Every day he brought a blacksmith to bang in his presence. . . . For thirty days this worked fine but then the gnat became accustomed [to the banging] and it resumed pecking.⁶⁶

Neurologist Bernard Dan describes this episode, though probably not historically factual, as “remarkably modern,” especially in its recommended treatment, which is “strikingly similar to current approaches” in sound therapy.⁶⁷ In short, the blacksmith solution uses a different sound to mask the hum of tinnitus in much the same way as white noise or ambient recordings are used today.

Many other accounts of tinnitus appear over the centuries, both as medical writing and as more general historical description. But by the fifth century we already see a nascent awareness that such a malady exists with different forms of sonic expression, emanating from the ear (or the auditory system

64. Celsus, *De medicina*, VI.7.8, 243.

65. Following these historical sources, I call the site/focus of this archaeology “the ear.” As mentioned above, most tinnitus is a psychoacoustic phenomenon associated with the brain’s auditory cortices. Tinnitus’s connection to the physical ear remains important, however, since damage to the inner ear hair cells seems to be one of the most salient causes of the condition. For more on the location of tinnitus, see Schlee et al., “Mapping Cortical Hubs.”

66. Quoted in Dan, “Titus’s Tinnitus,” 211.

67. *Ibid.*, 211–13.

more broadly) and causing it to sound, and that masking therapies might alleviate it. The following millennium and a half of Western medical science would mostly only refine these ideas.

An Archaeology of/by/in the Ear: Otoacoustic Emissions

Jumping ahead to the twentieth century, we find other instances of otic archaeology, often made audible through the confluence of listening composers and new developments in science. One such encounter that has become particularly iconic is John Cage's 1951 experience in an anechoic chamber at Harvard's Psycho-Acoustic Laboratory, built by the US military during World War II. He later recounted that he "heard two sounds, one high and one low," which were then described to him as his "nervous system in operation" and his "blood in circulation."⁶⁸ Whether or not Cage was experiencing tinnitus intensified by anechoic space, as some have suggested,⁶⁹ he draws attention to the possibility of listening to audible, physical emissions from the body.

Three years before Cage's anechoic experience Thomas Gold predicted a strange, and related, phenomenon while working at the University of Cambridge. He too worked in a laboratory devoted to wartime communication, and in 1948 authored an article fittingly titled "Hearing," in which he explored "the physical basis of the action of the cochlea."⁷⁰ In particular he argued that "the assumption of a 'passive' cochlea, where elements are brought into mechanical oscillation solely by means of the incident sound, is not tenable."⁷¹ In other words, the sheer force of a sound wave was not enough to generate the electromechanical activity that had been documented in the ear; the cochlea itself must be "active" in order to account for the ear's fine-tuned discrimination of frequency and loudness. He proposed a "regeneration hypothesis" by which the cochlea has "microphonic potential"—in other words, the inner ear functioned as, among other things, an amplifier.⁷²

Gold's hypothesis was either ignored or rejected by the psychoacoustics community (including those working in Harvard's anechoic chambers), but was picked up thirty years later by physicist David Kemp. Kemp was able to record the sounds generated by the cochlear amplifier by placing a microphone in the ear canal. In short, sounds enter the cochlea and set into motion a kind of reverse echo, which is amplified electromechanically by the outer hair cells of the cochlea in vibration with incoming stimuli, and then sent back through the ear canal as a feedback mechanism a few milliseconds later. Kemp called these feedback sounds "otoacoustic emissions."

68. Cage, "Experimental Music," 8.

69. See Revill, *Roaring Silence*, 153–54, and Prochnik, *In Pursuit of Silence*, 182–83.

70. Gold, "Hearing."

71. *Ibid.*, 492.

72. *Ibid.*

Kemp's critical methodology was listening to the ear, further refining a practice that had emerged with the study of tinnitus:

A number of people at that time had claimed to have been able to record tinnitus with a microphone put to the ear with tinnitus. One had found tones and another clicks. So *the idea of listening to an ear with a microphone* was not new even though the consensus was then (as it is today) that most tinnitus was not due to a physical vibration in the ear. But the idea of a sound coming out of a normal ear was indeed, novel. . . .

. . . I realized if there were physical resonances occurring inside the cochlea it should be possible to detect these from outside, acoustically in the ear canal, because of the way the middle ear links the cochlea and the ear drum.⁷³

Kemp points to the importance of tinnitus in setting the stage for his own experimental methodologies, but also offers a broader insight about the multidirectionality of the ear—a comment that resonates with Celsus's observation of the ear sounding (itself) within itself. The physiology of the ear means that sound can travel just as well out of the ear as into it, and thus that any sound entering the ear would in turn produce an echo that leaves the inner ear.

As they continued listening to and recording the sound of the ear listening, Kemp and his colleagues came to an even more radical conclusion: much like tinnitus, there was more than one type of otoacoustic emission, including some types that occurred spontaneously without any external stimulus. And in a remarkable double-feedback loop, somewhere between 6 and 12 percent of people who think they suffer from tinnitus in fact suffer from otoacoustic emissions that they themselves can hear.⁷⁴

Composing the Ear

These two brief historical glimpses of tinnitus and otoacoustic emissions offer preliminary steps toward a sonic archaeology of human hearing. While it appears that the former has more to do with the nervous system and the latter with the ear, both phenomena illustrate the complex ways in which audition may be auditioned. Again, composers and sound artists—some of the most famous sufferers of such conditions—have repeatedly found ways to employ such extended listening techniques in their work. Danish sound artist Jacob Kirkegaard, for instance, has composed multiple pieces and installations from spontaneous otoacoustic emissions, including *Earside Out* (2015). These compositions pose a complex phenomenological question:

73. Douglas L. Beck, "Otoacoustic Emissions, Tinnitus, Distortion Product OAEs, and Transient OAEs: Interview with David Kemp, PhD," American Academy of Audiology website, Interviews, January 6, 2009, accessed August 31, 2015, <http://www.audiology.org/news/otoacoustic-emissions-tinnitus-distortion-product-oaes-and-transient-oaes-interview-david-kemp> (my emphasis).

74. See Norton, Schmidt, and Stover, "Tinnitus and Otoacoustic Emissions."

what does it mean to listen to such remediations of listening? *Earside Out* can be understood as an experiment in listening to listening to listening. It is a powerful media recursion that not only reproduces the sounds of the ear but allows them to be edited, recombined, and listened to again.

Flattening as Cultural Technique: Epistemic and Aesthetic Functions of Inscribed Surfaces

SYBILLE KRÄMER

Time Axis Manipulation

The irreversibility of time is a strict invisible hand.⁷⁵ For all things living, all things aging and perishing, the direction of time is irreversible. This is particularly noticeable in human activities whose products are fluid acoustical vibrations—that is, speech and music. No sooner is the sound of language or music emitted than it disappears. The existence of tones consists in their disappearance. It was Friedrich Kittler’s ingenious insight that technical media open up the possibility of time axis manipulation, in which the order of time becomes a variable.⁷⁶ The spatialization of temporal processes in symbolic configurations makes their order and concatenation not only repeatable but also manipulable and reversible.⁷⁷ Thus it is unsurprising that the invention of written notation marks a watershed in both music and language. As is well known, the scriptualization of ephemeral sounding material brought forth new aesthetic forms, modalities of archiving, and distribution, as well as new means of compositional creativity.

The specific dimension of musical notation is usually interpreted as transforming the fluid sequence of sounds into a fixed graphic structure whose elementary direction is linear. The spatializing techniques of notation are, however, more complex. Scripts use two-dimensionality.⁷⁸ Think of written-down calculations, of headings and footnotes, of the direction of lines from top to bottom; think also of crossword puzzles. Kittler’s idea of time axis reversal is not far off: when uttered as an acoustic succession of sounds, a sentence cannot (or can scarcely) be reversed, whereas inverting the succession of letters in a written sentence is perfectly possible. Yet the operative potential of inscriptions is not limited to inventions of notations. It also includes all writing-down systems, or *Aufschreibesysteme*,⁷⁹ arising

75. Thanks to Alexander Rehding for translating this essay and for his insightful comments on it.

76. Kittler, *Draculas Vermächtnis*, 182. See also Krämer, “Cultural Techniques.”

77. See Kittler, *Literature, Media, Information Systems*, 130–46.

78. See Harris, “On Redefining Linguistics,” 39.

79. See Kittler, *Aufschreibesysteme*.

from the interaction of point, line, and area—that is to say, tables, graphs, diagrams, and maps.

Artificial Flatness

We live in a three-dimensional world, but we are surrounded by flat surfaces that are inscribed and illustrated. From skin tattoos and the first cave drawings, via inscriptions and maps, all the way to computer screens, tablets, and smartphones, we can trace a media-technological development based on the cultural technique of “flattening.”⁸⁰ We experience that which is “behind” or “beneath” as something unviewable and uncontrollable. But inscription and drawing flatten surfaces with depth into planes—that is, depthless areas. Empirically there is no such thing. But we treat inscribed surfaces as if they had no volume. Everything that matters is inscribed as a mark. What emerges is an artificial space that can readily be surveyed, processed, circulated, and archived. The inscribed surface opens up the possibility of representing theoretical connections by means of spatial relations, which makes them usable in technical operations. Is the familiar “rhetoric of depth,” which—in relation to philosophical thought—discredits superficiality and ennobles profundity, perhaps a compensatory response from the hermeneutic camp to the cultural technique of flattening?⁸¹ In any case, the inscribed and illustrated surface can then become an analytical tool, a thought laboratory, a technical workshop, and above all a playground of artistic ideas. Everything that is, everything that is not, and everything that can never be—all these entities can in principle be projected onto a surface and represented graphically. It is significant for the operative potential of artificial flatness that even logically contradictory objects can be visualized—think of the drawings of M. C. Escher and Oskar Reutersvärd.

The development of science and art is unthinkable without the cultural technique of using artificial surfaces; yet the cognitive and aesthetic implications of flattening have barely been sounded out.⁸² In musicology, notation is primarily in focus as performance instruction, be it conventional or avant-garde, as in the iconic scores of Earle Brown, Morton Feldman, Sylvano Bussotti, and Anestis Logothetis. By contrast, a different form of music inscription, not intended as performance instruction but as a tool of analysis, emerged in the seventeenth century, and especially in the work of René Descartes. We turn back now to that moment and to the development of what we might call diagrammatics, or the visualization of musical structures.

80. See Krämer, “Graphism and Flatness.” On cultural techniques, see Winthrop-Young, “Cultural Techniques.”

81. In relation to music, see particularly Watkins, *Metaphors of Depth*.

82. With a few exceptions: see Summers, *Real Spaces*, and Sommer, *Von der Bildfläche*.

Descartes's *Musicae compendium* and the Epistemic Use of Diagrams

René Descartes (1596–1650) is a central figure in mathematics, insofar as his invention of analytical geometry overcame the schism between arithmetic and geometry, which had ruled math since the discovery of incommensurability (that is, the lack of a common numerical measure between the side and diagonal of a square) in ancient Greece.⁸³ This solution became possible on the basis of Descartes's pioneering coordinate system—not then yet represented as orthogonal axes—now known as “Cartesian.” Descartes introduced a referential system of lines that allowed the identification of geometric points as arithmetic pairs of numbers such that curves can be expressed by equations and geometrical problems can be calculated. In Cartesian analytical geometry figures can be translated into formulas and vice versa. Coordinate axes territorialize the page into well-defined regions. Numerical space is mapped out so that numbers, usually invisible, are assigned a well-defined perceptible local position. Thanks to this “cartographic turn” in math, Descartes became convinced of the epistemic power of lines. Less well known is the fact that he initiated this turn to the use of lines as a frame of reference in his writings on music.

His *Musicae compendium* (1618), though not published until 1650, the year of his death, was actually Descartes's first completed treatise. Its content is significantly influenced by Gioseffo Zarlino's treatises *Le institutioni harmoniche* (1558) and *Dimostrazioni harmoniche* (1571).⁸⁴ But what stands out in Descartes's treatise is his innovative use of diagrams in an *epistemic* role—that is, a role that furthers and grounds the knowledge presented. While musicology has shown some awareness of this text, philosophical discourse has barely taken note of it.⁸⁵ The diagrams developed in the *Compendium* transform audible music into a visual constellation of lines. An eye-catching feature of the treatise is the diagrammatic representation of tonal relations by means of lines and circles (see Figures 1 and 2).⁸⁶ Descartes aims to avoid reducing music to the non-sensual skeleton of visualized relation, hoping rather to explain the *sensual qualities* of experiencing music as a phenomenon. The famous opening statement of the *Compendium*, “Huius objectum est sonus” (Its object is sound), underscores this programmatic outlook.

83. Descartes, *La géométrie*.

84. H. Floris Cohen sees Descartes as pure follower of Zarlino: Cohen, *Quantifying Music*, 163. For a critique of reducing Descartes to “Zarlinoism,” see Muzzulini, “Geometry of Musical Logarithms.”

85. Recent musicological discussions include Lohmann, “Descartes' ‘Compendium musicae’”; Gozza, *Number to Sound*; and Moreno, *Musical Representations*. For a study outside of music, see Sepper, *Descartes's Imagination*.

86. Figures 1 and 2 are reproduced from Descartes, *Musicae compendium*, 16, 20.

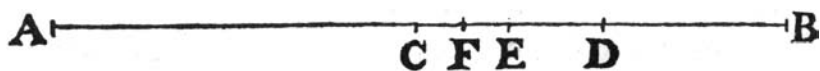


Figure 1 Descartes's presentation of concordances by successive divisions of a line

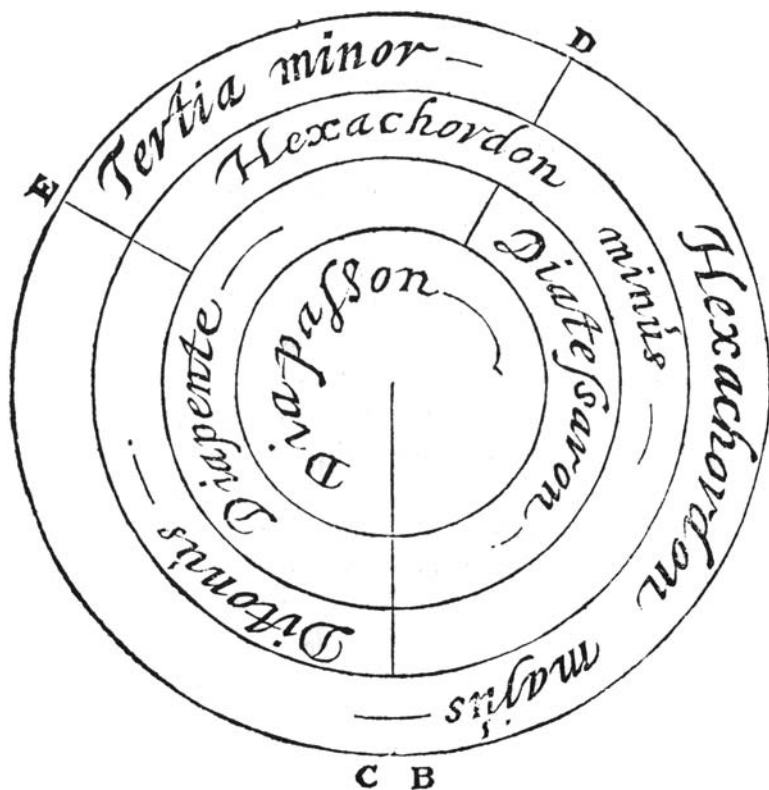


Figure 2 Descartes's presentation of the consonant intervals within the octave

One of the points he makes through the innovative use of diagrams pertains to the different effects of consonant and dissonant intervals, which he explains in five steps:

- 1 His point of departure is the distinction between commensurable (“arithmetic”) and incommensurable (“geometric”) line proportions.⁸⁷ Where intervals sound *consonant*, proportions between tones

87. *Ibid.*, 4–5.

can be visualized if they have a common divisor. For *dissonant* intervals, tonal relations cannot be visualized by means of proportional lines based on a common smallest unit. With these two kinds of line proportions he has created a universal system with which to explain fundamental musical relations—not dissimilar to the role played by his invention of the coordinate system in mathematics.

- 2 Descartes can now represent consonances, following arithmetic proportions, as the relation between lower and higher tones. Using the octave as an example, he demonstrates his principles graphically by successively dividing a line segment into two unequal parts—yielding octave, fifth, and then a major third. The consonances are *based* on the division of the line segment representing the octave; in other words, they are *contained* in the octave, as the visualization clearly suggests.
- 3 Descartes points out that these diagrammatic proportions correspond to string instruments, each pitch relating to the length of a vibrating string. The space he chooses for his representation of the harmonically divided line is the visual representation of those frequencies, which the proportionally divided string of the monochord turns into sounding reality.⁸⁸
- 4 The realization that “all simple consonances are contained in the octave”⁸⁹ is underscored by one further diagrammatic operation: Descartes bends the straight lines into circles. In this way the intervals are represented as concentric rings nested inside one another. With the aid of this circular diagram he develops a typology of three kinds of consonances corresponding to circles in different locations.
- 5 Descartes conceives of his musical diagrams as both pedagogy and compositional guide, ensuring that composition be free of “grave errors or mistakes.”⁹⁰

With such diagrams Descartes examines various parameters of musical tone in his *Compendium*. What matters for our purposes is that the representation of fluid sounds in the medium of spatial-visual configurations serves not merely to depict musical situations but to examine them analytically and to ground and elucidate aesthetic aspects of music. In other words, Descartes seeks to explain the phenomenon of consonance—which he figures explicitly as an auditory impression—by means of a spatial representation in

88. *Ibid.*, 18–19.

89. *Ibid.*, 18: “omnes consonantias simplices in octava contineri.”

90. *Ibid.*, 56: “gravi errore vel soloecismo.”

the visual domain. It is no coincidence that “it is clear from this figure . . .”⁹¹ is his preferred turn of phrase in this context. Importantly, his philosophy is based on the idea that it is not things that determine methodology; rather it is methodology—in this case, the visualization of musical data—that produces “things” as objects of scientific inquiry. This is possible only if phenomenal objects are scientifically represented by means of a general “language” or reference system. The straight lines, circles, and charts in Descartes’s music theory form a referential system: all musical relations must be input as a necessary step to becoming objects of knowledge.

Outlook: Digital Surfaces

Finally, two concluding points. First, the cultural techniques of alphanumeric space transmit the continuity of fluid temporal processes into a discrete structure of notated space, mapped onto the inscribed flat surfaces. This inscribed surface serves not solely for writing, calculating, and reading, but also for depicting lines in schematic configurations, which—while representational—are beholden to the discrete regime of schematization. Just as Descartes’s analytical geometry enables the translation of figures into formulas, so his musical diagrammatics brings about the translation of series of tones into figures that can be schematized and numerically determined. Either way, spatial relations on the surface become the thought-tools and media of epistemic insights. Immanuel Kant posited space and time as *equivalent* forms of intuition.⁹² But does not the cartographic turn, which goes hand in hand with the impulse to transform time-bounded processes into spatial relations, rather indicate that whenever we “move” in complex areas of knowledge we privilege space and spatiality as a medium and instrument over temporality? Are we not “spatial creatures” in terms of both practical and theoretical orientation?

This leads to a second question: what happens if alphanumeric space turns into digital data space, if the inscribed surface becomes a networked interface? On the one hand, the exponential growth of screens in smartphones attests to the ubiquity of flat areas: virtual surfaces, sites of artifice, have become fused with human hands. On the other, the electronic interface regains what the inscribed surface had cut off: an unfathomable and uncontrollable depth-structure lying “beneath,” now referring to the layers of the data universe connected by hyperlinks. Is it possible that the digital transformation and return of data obfuscation weaken the primacy of space? (Think, for instance, of the philosopher Alexander Galloway and his “black box” principle—an apparatus that mediates between visibility and invisibility to raise questions about unrepresentability in a world in which information has

91. Ibid., 20: “Ex hâc figurâ apparet . . .”

92. Kant, *Kritik der reinen Vernunft*, 1:69–96.

reached saturation point.)⁹³ Does this herald a new significance of temporality as a medium of knowledge? Sampling and simulation point in that direction. But that is another story.

Let us not forget: alphanumeric space and networked data space do not exist in a relationship of succession, one supplanting the other. Rather, digitization realizes a potential that is inherent in the cultural techniques of the alphanumeric realm. After all, the epitome of such discreteness—the vantage point of the digital—is classic writing, which has long been structured by disjunct entities such as letters, spaces, and punctuation. Against this background the step from alphabetic (and musical) writing to the digital world of zeros and ones is not as great as it might appear. Returning to the seventeenth-century father of the digital, it seems more than fitting that Leibniz's *Dualsystem* is often referred to as a “binary alphabet.”⁹⁴

Rehear(s)ing Media Archaeology

ROGER MOSELEY

Toward the end of his life Friedrich Kittler remarked that “music was always the interface between my technical and historical interests” since “music is ideally understood as simply a variable of time.”⁹⁵ Reciprocally, time can be experienced as a function of music. In shuttling between these perspectives, the contemplation of music has given rise to sophisticated accounts of temporal parallax, whether figured in terms of cause and effect, of historicity and futurity, of vector and loop, or of sequence and synchronicity.⁹⁶ Recently, however, the flourishing of media archaeology has called the discursive means of reckoning such accounts into question. As Thomas Elsaesser observes, this has to do with the suspicion surrounding progress, regress, and teleology of all stripes, but it also reflects a “crisis in memory and recall” precipitated by the ubiquity of contemporary digital technologies that promise (or threaten) to flatten the topography of history and to outmode narrative methods of tracing its course.⁹⁷

The work of Wolfgang Ernst can be read as both symptom and diagnosis of this crisis. Ernst has made a point of addressing sonic media technologies that, as they process fluctuating signals, do not simply operate within extant chronological frames but generate temporalities that exceed the limits of

93. Galloway, “Black Box, Schwarzer Block.”

94. See Krämer, “Leibniz on Symbolism.”

95. Quoted in Ernst, “Kittler-Time,” 59.

96. See, for instance, Dahlhaus, *Foundations of Music History*; Kramer, *Time of Music*; Albright, *Untwisting the Serpent*; Trippett, “Composing Time”; Tobias, *Sync*; and Rehding, “Discovery of Slowness.”

97. Elsaesser, “Media Archaeology as Symptom,” 188. See also Sybille Krämer's contribution to this colloquy.

human consciousness.⁹⁸ Ernst defines “sonicity” writ large as a site “where time and technology meet.”⁹⁹ Throughout this domain, the frequency of events on scales ranging from the geological to the ultrasonic is perceived to engender cyclical resonances and reverberations that render the concept of “a linear flow of time . . . an anachronism,” in Barry Truax’s words.¹⁰⁰

Ernst’s experimental pursuit of media archaeology is performative to the extent that its nondiscursivity must be staged and enacted rather than merely described. What is more, Ernst insists that the apprehension of media technologies be guided by a firm technical grasp of the principles according to which they are materialized.¹⁰¹ This entails not only the investigation and preservation of technological artifacts to a degree that can verge on the fetishistic, but also the reconstruction and (where necessary) the simulation of the ecological systems in which they first came to be in order to summon and channel the prevailing *Eigenzeitgeist*.¹⁰²

In musical terms, this emphasis on getting to grips with historical evidence through the acquisition and demonstration of experiential knowledge echoes nothing less—or more—than the praxis of historically informed performance. Like the resurrection of obsolete media devices, the restoration, replication, and animation of historical instruments require intimate knowledge of the mathematical and mechanical tenets that informed their design, as well as cultivation of the technical know-how and aesthetic sensibilities associated with their operation. However troublesome and elusive its realization might be, media archaeology and historically informed performance both depart from the optimistic notion that the rift between the past and the present is at least momentarily bridgeable via the persistence of material evidence and the reproducibility of sonic phenomena from one era to another. In this regard, media archaeology proposes new ways of framing played-out debates concerning the scope of historical propriety vis-à-vis the limits of contemporary understanding.

From the Pythagorean monochord to the synthesizer by way of Vincenzo Galilei’s lute, musical instruments play a crucial role in Ernst’s epistemology because they enable us to “share and participate in the original discovery of musicological knowledge.”¹⁰³ Instead of being recalled, such knowledge is called forth. Insofar as music configures its own temporality, it thus indexes not so much change or stasis, and still less a clearly discursable succession of events, but rather what Vivian Sobchack identifies as the ongoing “‘presence’

98. Ernst, *Sonic Time Machines*.

99. *Ibid.*, 21.

100. Truax, *Acoustic Communication*, 115.

101. See Parikka, “Operative Media Archaeology.”

102. See Ernst, *Sonic Time Machines*, 93–102. On the notion of *Eigenzeit*, see also Gundula Kreuzer’s contribution to this colloquy.

103. Ernst, *Sonic Time Machines*, 91.

of the past in the present.”¹⁰⁴ Robert O. Gjerdingen’s assessment of the time-traveling potential that eighteenth-century *partimenti* hold in store for today’s keyboardists might be considered in this light: “For intrepid twenty-first-century voyagers who venture into the virtual world where a *partimento*’s imaginary voices can be heard still singing out the schematic patrimony of a centuries-old tradition, there are intense experiences to be shared with the elite musicians of the eighteenth century.”¹⁰⁵ By staging the transhistoricity of “presence,” both media archaeology and historically informed performance foreground the extent to which all music must be generated in real time via sophisticated technologies and techniques that are liable to pass undetected by minds, bodies, and sensoria not attuned to their specific frequencies.

Both more specifically and more generally, media archaeology draws our attention to the fact that all processes of selection, storage, and retrieval are mediated via human and mechanical means that require a continual investment of energy, whether electrical, muscular, or affective. On a micro-temporal level, the seeming stability of data stored on hard drives and images arrayed on monitors must be recognized as media effects that, as they exploit and concede to perceptual capacities and limitations, conceal constant processes of activation, loss, and regeneration.¹⁰⁶ On a larger scale, the fact that a World War II-era radio can today play the music of Beyoncé prompts us to construe the variable historical and cultural meanings of signals in relation to the ongoing presence of their technical channels.¹⁰⁷ Rather than ascribing the course of events to revolutionary dynamism, inertial conservatism, or the biological processes of embryonic development, maturation, and senescence, media archaeology emphasizes the wave-like periodicity with which particular assemblages of signals, technologies, and techniques tend to recur.

A sensitivity to alternative modes in which the world might be registered, processed, and described—ultimately, as Sobchack observes, to its “marvelous ‘otherness’ from the way we would think it”¹⁰⁸—characterizes media archaeology’s distinctive approach. Alertness to these possibilities is a token of resistance to the hegemony of “the way things are” insofar as it attends to phenomena that fall outside the purview of history’s narrative sweep. The instruments of media archaeology enable us both to sense and to make sense of material affordances and constraints by probing the limits of a system. Beyond that, they promise to restore “presence” to the past by exhuming “the material remains of bold thoughts, eccentric ideas and brave hopes that encourage one to entertain the vision of a different future from the one already prepared,

104. Sobchack, “Afterword,” 328.

105. Gjerdingen, “*Partimento, que me veux-tu?*,” 132.

106. See Kirschenbaum, *Mechanisms*, 73–109, and Ernst, *Sonic Time Machines*, 29.

107. See Ernst, *Digital Memory*, 56–57, and Kreuzer’s contribution to this colloquy.

108. Sobchack, “Afterword,” 327.

processed and pre-mediated for us,” as Elsaesser puts it.¹⁰⁹ In contriving to frame chronically outmoded artifacts as both harbingers and keepsakes of an imaginary future, media archaeology forges what Erkki Huhtamo dubs “topical” connections by way of morphological similarities between otherwise far-flung phenomena.¹¹⁰ At the same time, it makes apparent the extent to which all efforts to reanimate the past stage themselves as such in a subjunctive mood (less “wie es eigentlich gewesen” than “as it might have been” or “as it could yet be”).¹¹¹ Whether in the laboratory, the concert hall, or the archive, such endeavors always involve an element of make-believe, of creation and recreation, performance and “deformance,” simulation and dissimulation.¹¹²

Yet for all its countercultural and counterfactual commitments, media archaeology is beholden to the dominant contemporary technologies that it subjects to critique. To a certain extent this reflects an agenda rather than a blind spot. Stressing the importance of native-level fluency in the languages and codes of media, Ernst contends that descriptions of technological phenomena should more nearly approach the inscriptive logic that informs the operations of such devices and the media they process.¹¹³ For digital technologies, this involves the algorithmic performance of ordering, counting, and calculating. On the one hand, as Alexander Rehding notes in his contribution to this colloquy, such processes might seem diametrically opposed to humanistic endeavors that have focused on the expression and registration of artistic ideas by literary means. On the other, as Ernst points out, the closely related etymology of terms having to do with both narration and calculation is “telling” (to invoke a term as applicable to financial transactions as it is to stories).¹¹⁴ In the course of counting, accounting, recounting, or discounting, numerals and letters are typically placed and effaced in sequential order, reflected by their spatial arrangement on the page as well as by the temporal logic of their algorithmic processing. It is via this spatio-temporal fungibility that Ernst compares all digitized signals to “the tradition of [Western] music notation,” whether they are stored as strings of symbols (in “memory”) or streamed in real time (as “code”).¹¹⁵

109. Elsaesser, “Media Archaeology as Symptom,” 188.

110. Huhtamo, “Dismantling the Fairy Engine.” Here, again, media-archaeological terminology echoes musicological discourse, as represented by Ratner, *Classic Music*, Allanbrook, *Rhythmic Gesture in Mozart*, and Mirka, *Oxford Handbook of Topic Theory*.

111. As Ernst phrases it, “Media-archaeological research can never definitively reconstruct what has been said (or sung), but rather explores and defines the conditions of possibility regarding what *could have* been enunciated”: Ernst, *Sonic Time Machines*, 57.

112. On the poetics of “deformance,” see Samuels and McGann, “Deformance and Interpretation.”

113. See Parikka, “Operative Media Archaeology.”

114. Ernst, *Digital Memory*, 147–57.

115. Ernst, *Sonic Time Machines*, 110. See also Moseley, “Digital Analogies,” 187–93. On occasion Ernst exhibits a shaky grasp of musical and musicological particulars: see, for example, his reference to “Johann Sebastian Bach’s notorious *Well-Tempered Piano* pieces” and his

Throughout the practices surrounding the transmission of written music, notes join letters and numerals insofar as they are made meaningful via a common symbolic logic predicated on the neat separation of identity from difference. The same Leibnizian digital principle according to which one thing can be told apart from another undergirds the disposition of a *partimento* across a staff, its optional annotation with figures, its verbalization by way of letters and solmization syllables, and the serial alignment of the keys at which its implied sonorities are realized in parallel.¹¹⁶ Writ large, this symbolic commutability permits otherwise disparate phenomena to be identified, collected, classified, compared, distinguished, and juxtaposed, whether they are curated in physical proximity, subjected to corpus analysis, or aggregated by Google's algorithms.

Under these conditions, as Kittler noted in relation to the historical ordering of paintings hung in Berlin's Altes Museum, chronology's claim to be the default mode of organizing material or information is subject to challenge.¹¹⁷ Rather than the date of an object's creation or modification, its size, kind, alphabetization, or tagged metadata might determine its place in the order of things. But these criteria, which at once enable and compel users of macOS (such as myself) to collate the spatially scattered contents of its file system, hint at the way the most telling connection or whimsical oxymoron can be explained (away) as a digital artifact of automated or crowdsourced algorithmic procedures.¹¹⁸ Even—perhaps especially—when marginally askew, the specificity of Google's, Amazon's, or Spotify's recommendations bespeaks the fuzzily precise logic according to which historical threads can be interwoven and our most idiosyncratic tastes processed to be fed back to us.

It is for this reason that Elsaesser treats the recuperative efforts of media archaeology—and in particular its carving out of a future for obsolescence—as indicative rather than curative (or even comprehensively diagnostic) of our digital condition.¹¹⁹ In the case of Spotify, do its recommendations indicate alternative modes of listening, understanding, and analyzing that humans would do well to emulate, or do they simply expose the ruthless logic of capitalism? Do they contiguously extend long-established curatorial techniques and social mechanisms of taste formation, or do they offer proof of the computer's utter indifference to human criteria via its exclusion of the

blanket assertion that “electronic synthesizers have thus far been subject to equal tuning”: Ernst, *Sonic Time Machines*, 97.

116. On Leibniz's systemization of binary arithmetic, see Krämer's contribution to this colloquy and Moseley, “Digital Analogies,” 166–68.

117. Kittler, “Museums on the Digital Frontier,” 68.

118. On the predicaments in which digital tools can place archival musicologists, see Walton, “Quirk Shame.” Walton's essay forms part of a “special forum” edited by Nicholas Mathew and Mary Ann Smart, who frame the music-historical implications of such media-archaeological symptoms under the rubric of “Quirk Historicism”: Mathew and Smart, “Quirk Historicism.”

119. Elsaesser, “Media Archaeology as Symptom,” 201–9.

unswitchable and unquantifiable?¹²⁰ Or does Spotify reveal, perform, and represent all these possibilities at once? If so, digital media do not so much “determine our situation,” as Kittler’s incendiary aphorism has it,¹²¹ as determine how our situation can be deemed determinable in the first place.

Such recursions hint at the means by which media archaeology rehearses—in the dual senses of anticipating and recapitulating—concepts and acts from the musical past.¹²² Kittler held that “harmony is always new, and yet . . . always the same. This is what references to forwards and backwards ought to suggest. At one moment the threads branch out like a fork, at another moment the separated threads intertwine themselves again into a mesh.”¹²³ Along analogous lines, it might be argued that media archaeology is also “new, and yet always the same.” In their contributions to this colloquy Alexander Rehding and Gundula Kreuzer observe that Kittler’s techno-deterministic “media science” leans heavily on figures (Hegel, Adorno, Dahlhaus) whose agendas he vehemently disavowed. Similarly, the genealogy of Ernst’s “sonicity” is rooted in the traditions of systematic musicology, the discipline’s fractious relationship with its historical counterpart, and the ideology of absolute music.¹²⁴

These connections become explicable in light of Sobchack’s identification of the “historical materialism [and] antihermeneutic bent” of media archaeology as at once “particularly Romantic” and decidedly formalistic.¹²⁵ In this regard, Ernst’s clinical presentation of the sonic past is redolent of Eduard Hanslick, for whom the sheer presence of music ultimately obviated all attempts to account for it in historical, critical, or programmatic terms (including his own).¹²⁶ Rather than merely recycling Romantic material, however, the work of both Kittler and Ernst recursively rehearses it. From this standpoint, music as a media-archaeological phenomenon emerges not only from

120. See Chodos, “Critical Perspectives.” Spotify explicitly seeks to eliminate human “bias” in the process of making decisions and recommendations: “New engineers at Spotify will notice that the culture has a way of engulfing you in a data-driven mindset. . . . Spotify strives to be entirely data driven. We are a company full of ambitious, highly intelligent, and highly opinionated people and yet as often as possible decisions are made using data. Decisions that cannot be made by data alone are meticulously tracked and fed back into the system so future decisions can be based off of it. How fantastic is that? Sounds robotic, but humans cannot be trusted so it’s cool”: Jason Palmer, “Analytics at Spotify,” Spotify Labs, May 13, 2013, accessed June 28, 2016, <https://labs.spotify.com/2013/05/13/analytics-at-spotify/>. I am grateful to Chodos for bringing Palmer’s post to my attention. On Kittler’s (dis)ontology of the “(un)switchable,” see Rehding’s contribution to this colloquy.

121. Kittler, *Gramophone, Film, Typewriter*, xxxix.

122. See, for instance, Peter McMurray’s contribution to this colloquy, in which he explores how the act of listening can be constituted and (re)processed by the recursive operations of media archaeology.

123. Quoted in Ernst, “Kittler-Time,” 61–62.

124. See Ernst, *Sonic Time Machines*, 134–35, 96.

125. Sobchack, “Afterword,” 328–29.

126. As Hanslick put it, music (like the other arts) “can be understood only by studying its technical limits and its inherent nature,” which depends in part on “the nature of its medium”: Hanslick, *The Beautiful in Music*, 16.

instrumental technologies and vocal techniques, but also from the Hoffmannian poetry and criticism that discursively stored and transmitted its nondiscursive qualities at the onset of the nineteenth century. As “poetry raised to a higher power,” in Robert Schumann’s formulation,¹²⁷ music became conceivable by way of the very alphabetic symbols its meaning exponentially exceeded.

In the twentieth century the advent of historically informed performance staged the temporality of sonic enactment precisely at the post-phonographic juncture when the practice of making music turned from an unmarked contemporary phenomenon into a relic of an unsalvageable past. Again, new aesthetic possibilities were made imaginable by the limitations as well as the capacities of a technology that promised to realize dreams of musical time- and space-travel. Today, the Romantic rhetoric of autonomy, ephemerality, and fugitivity has migrated one stage further, from representations and enactments of sonic experience to the medium of sound itself. As Brian Kane notes, a stratum of scholarship within sound studies has stitched together the shopworn remnants of Romantic aesthetics in order to ground ontological fantasies of the ineffable.¹²⁸ Oscillating between technical detachment and transcendental rapture, Ernst’s prose ultimately underwrites the same enterprise.

To imagine alternatives in the terms expounded by Rehding we might deploy media archaeology not as a totalizing method but as a set of cultural techniques that construct the means by which music’s temporality becomes apprehensible.¹²⁹ At the same time, we might turn back to music as evidence of how sonic transience can be cultivated and sustained. If media archaeology encourages us to listen afresh to familiar musical patterns, then the rehearsal of such patterns reveals in turn how music never ceases to create the temporal domains it occupies. From this perspective, all music constantly aspires to the condition of a *partimento* insofar as it responds to the teasing out of melodic and discursive counterpoints that are at once discovered and invented, retrieved and generated, old and new.

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127. Quoted in Daverio, *Robert Schumann*, 43. On the literary, poetic, pedagogical, and bureaucratic techniques by which such operations were performed in early nineteenth-century Germany, see Kittler, *Discourse Networks*, 3–173.

128. Kane, “Sound Studies.”

129. See Siegert, *Cultural Techniques*; Winthrop-Young, “Discourse, Media, Cultural Techniques”; and Rehding’s contribution to this colloquy.

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