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The Logic of Filtering

Over their one-hundred-forty-year history, sound media have undergone a spectacular development. Beginning as relatively simple machines, which could transmit, store, and replay sound with only limited spectral resolution and limited dynamic range, they have become highly complex technologies that can store, transmit, analyze, manipulate, reproduce, and produce sounds with a definition that equals any non-technological sound. From the very beginning, much of the impetus driving this development has stemmed from the myth of perfect fidelity: the idea that sonic "reproductions" might progressively come to resemble their "originals" exactly. This entails eradicating any difference between what goes into sound media and what comes out of them. Indeed, if the ideal of perfect fidelity is to be fulfilled, not even the smallest detail can be lost during the signal's journey from input to output, and no artifact can be added, however tiny. Any such lack or addition constructs a relationship between input and output in terms of represented and representation, original and copy, complete and incomplete, before and after. The ideal copy would cease to be a copy, for it would have been purged of any trace of what makes sonic replication possible in the first place: the channel *in between* input and output. This is why many technological advancements have implicitly or explicitly striven to prevent, eliminate, or at least maximally reduce these traces: to conceal the channel in favor of seemingly clear, entirely noiseless, completely unaffected signals.

The myth of perfect fidelity, then, presupposes this (impossible, idealized) goal of completely removing or reducing sonic traces of the material basis of signal transmission. Accordingly, the transmission process has often been represented as an ideal, infinitely accurate filter that cleanly separates the noisy artifacts of material sound reproduction (external sounds) from the pure, unaffected signals that are being reproduced (internal sounds). This is what I call the *conceptual logic of noise reduction*, the discursive origins of which reach back at least to the development of the infinitesimal calculus in the seventeenth century. Later, having been further honed and articulated through Fourier analysis in the nineteenth century, this logic was applied to the study of sound and development of technical media in the nineteenth

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and twentieth centuries. By representing sound in terms of clearly delineated series of infinitely oscillating sine waves, models of sound based on Fourier analysis assume an entirely rational world in which every part of every sound has its proper, unambiguous, and unchanging place. Before I move beyond this idealistic model altogether in the final part of my argument, it might be good to briefly recapitulate the historical emergence of the discursive separation between sounds/signals and noise that took hold from the nineteenth century onward. This distinction, I mean to emphasize, supports the logic of noise reduction.

Building on Ohm's application of Fourier analysis to the study of periodic sounds, Helmholtz's work in the second half of the nineteenth century greatly advanced the understanding of the physical nature of sound and the physiology and psychology of human hearing. The musically minded Helmholtz fully acknowledged that nonperiodic noises accompanying instrumental sounds "facilitate our power of distinguishing them in a composite mass of sounds."[1] Nevertheless, both the mathematical principles of Fourier analysis and his training in the tradition of Western music theory led him to differentiate between musical *sound* composed of periodic vibrations, and unmusical *noise* composed of nonperiodic vibrations. For Helmholtz, then, the idealized periodicity of perfect sine waves sustained the ideal of well-ordered musical sound. Accordingly, his work perpetuated the idealistic separation between (nonmaterial, pure, harmonic) *music* and (physical, impure, dissonant) *noise* that Western music theory, and the alphanumerical logic of music notation, had upheld for centuries.[2]

The conceptual separation between signal and noise was further consolidated in the first decades of the twentieth century with the transition from acoustics to electro-acoustics and rapid developments in communication technology.[3] The demand for reliable signal transmission fostered by the telephone, telegraph, and radio precipitated a reconceptualization and standardization of the physical categories of "signal" and "noise." This aided the development of more sophisticated ways of preventing and reducing the transmission channel's negative effects on the transmitted signal. After World War II, information theory further formalized the basic principles underlying these technologies.

On the one hand, information theory originated in the practical concerns of communication engineering and its incentive to maximally reduce the

[1] Helmholtz, *Sensation*, 101.
[2] Helmholtz, *Sensation*, 11–13.
[3] Wittje, *Age*, 203–206.

noise of transmission channels. As such, it perpetuates ideals of clarity, purity, order, and regularity that characterize scientific modernity. In striving for an ideal filter, perfect transmission, and unambiguous signal-to-noise ratios, it further cemented idealist tendencies in the postwar discourse on communication technology. On the other hand, Shannon's model of communication provides a mathematical basis for the physical observation that a minimum amount of noise is unavoidable. As the uncertainty principle shows, accurate representation or reproduction in the spectral domain always comes at the cost of losing information and adding noise in the temporal domain, and vice versa. However accurate and advanced a system may be, each channel introduces transience to the transmitted signals in ways that no filter can fully predict, prevent, or eliminate. Although technological noise-reduction systems aim to reduce these artifacts, they are also physical channels themselves. As such, they inadvertently shape the signal too. The communicational concept of noise, then, dispels the ideal of absolute noise reduction, putting dreams of perfect fidelity and an ideal filter firmly beyond the horizon.

The uncertainty principle emphasizes the fundamental impossibility of complete representation or reproduction, and information theory shows that noise is a property of the channel itself, and as such never fundamentally reducible. Still, to frame these observations in terms of an *impossibility*—to argue that it is *impossible* to achieve perfect reproduction—would be to preserve the significance accorded to visions of the ideal filter. The dream of perfect clarity and absolute transparency would persist as the ultimate, albeit unattainable, point of reference in conceptions of sound media. Just as Kittler's dream of *im*mortality on the plane of the ideal filter acknowledges mortality in the domain of technical filters, and sine waves' symbolic *in*finity highlights the inherent finitude of physical signals, so the *im*possibility of achieving total transparency only becomes meaningful by way of contrast to absolute perfection. Although such perfection may be unattainable, it is nonetheless desired and conceptually central. One can embrace the physical world's imperfections, champion unpredictability and randomness, or extoll the virtues of noise and distortion. Nevertheless, if in so doing one foregrounds their transgressive or subversive power, their ability to disrupt or upset order (musical and social), then one also upholds the discursive primacy of the very idealist position that one seeks to reject.

Moving beyond the perpetually antithetical relation that obtains between noise, distortion, transience, and randomness on the one hand, and the supposed transparency and purity of ideal filters on the other, requires a moratorium on comparisons between the output of technical operations and the infinitely perfect accuracy of ideal filters. To break the circle in which the

actual is set off against the ideal, one must attend instead to everything that emerges at the messy crossroads between the impossible extremes of the uncertainty principle. One must recognize sine waves and Dirac impulses for what they are—nonexistent abstractions—and embrace the complexity of everything that exists in the middle, extending in space and changing over time. In developing this reorientation, this final chapter proposes to break radically with the conceptual logic of noise reduction and replace it with a *logic of filtering*. Conceptually replacing the ideal filter with physical filters, the logic of filtering foregrounds channels *themselves* as the primary agents in sound reproduction. It is channels that produce specific sonic qualities, channels that give rise to the continuous push and pull of pastness and presence that characterizes all technologically (re)produced music.

The Primacy of Filters

Digital technologies provide perhaps the clearest example of how the conceptual logic of noise reduction conceals the influence of the channel and depends on notions of an ideal filter. Digital media are predicated on the complete reduction (or filtering out) of the physical noise of their material (analog) circuitry. On this basis, they are able to process series of discrete signs that not only represent but actually reproduce physical sounds. Digital media can easily reproduce sounds both within and beyond the range of human hearing. Indeed, they can even create entirely new sounds. For Kittler, only their detailed, real-time sound processing provides a truly viable "language for sound, that is for unforeseeable, unthinkable, unimaginable acoustic events."[4] As I explained in chapter 3, however, even digital sound media run into physical limitations that prevent absolute representation or reproduction. Whereas the mathematical operations of Fourier analysis can process the potentially infinitely long values of physical amplitude levels, computers rely on rounding such values off.[5] This introduces quantization errors that require the addition of dither noise.

For anyone who takes an ideal filter (boasting perfectly clear sine waves and absolute temporal exactitude) as the ultimate measure of perfection, the distortion caused by digital rounding-off errors is an acoustic reminder of digital

[4] Friedrich Kittler, "'Bei Tanzmusik Kommt Es Einem in die Beinen," in *Auditive Medienkulturen: Techniken des Hörens und Praktiken der Klanggestaltung*, eds. Jens Schröter and Axel Vollmar (Bielefeld: Transcript, 2013), 40, 35–42.

[5] Friedrich Kittler, "Real Time Analysis, Time Axis Manipulation," in *Draculas Vermächtnis: Technische Schriften* (Leipzig: Reclam, 1993), 199.

media's insufficiency when it comes to reproducing sounds in full temporal and spectral detail. For such a person, the dither noise added to randomize quantization errors and prevent distortion represents a psycho-acoustic stopgap meant to disguise this insufficiency. According to this idealist logic, by trading statistically correlated digital artifacts for a more "natural" and less obtrusive noise floor, dithering serves to convince the listener that the sound coming out of the speakers is a faithful reproduction of the original signal. It is designed to sustain the illusion that the bond between original and copy is unbroken, that the ideal of perfect representation remains within reach.

The symbolic rigor of the digital procedure, however, highlights the fallacy of this perspective. It throws into sharp relief the fact that the so-called clarity of perfect reproductions (in comparison with which any technical representation or reproduction is always already insufficient) is not inherent to the input signal. Rather, it is a product of the mathematical idealizations that constitute the symbolic foundation of the digital procedure itself. Neither the "original" input nor "reproduced" output actually showcase the smoothness and clarity of a mathematical limit case: such smoothness and clarity belong instead to the representational model itself, and to this model only.

Unlike this smoothness and clarity suggested by idealized filtering operations, signals produced by technical filters require a physical cut so as to balance accuracy in time and frequency. This physical cut is the defining figure of the logic of filtering. It underscores how signal transmission relies not on fully open gates or transparent windows, but on filtering channels that introduce noise, transience, randomness, and distortion. Perceived in relation to idealized visions of totally clean inputs and clear outputs, the artifacts of filtering channels will always be interfering byproducts. The logic of filtering, however, stresses that it is neither sender nor receiver, but the operations of a parasitic third term (the channel itself, administering a physical cut) that produce the rich, complex, nonperiodic, and random sounds of technological media. These operations make the sounds of technical media resonate meaningfully in the ears of listeners.

The primary components of the logic of filtering are illustrated by an ongoing series of pieces by Toshimaru Nakamura, released since 2000 under the title "Nimb" (short for "no-input mixing board").[6] As this title suggests, these pieces are produced using a mixing board without any sound-generating input sources. In the absence of any external sound source, the mixing board's own output sources are directly fed back into its inputs, creating a feedback loop. In this way, the noise of the board's electrical circuitry is picked up and

[6] *No-Input Mixing Board*, by Toshimaru Nakamura, Zero Gravity, 2000, compact disc.

amplified by its own channels. This noise is subsequently shaped by the artist, who filters out or emphasizes certain frequencies, adds sound effects, and manages the volume of the various loops.[7] Although they are all based on this relatively simple process, the pieces that Nakamura has produced over the past decades (simply called "Nimb #8," "Nimb #25," or "NIMB 54," etc.) are astonishingly varied. They range from harsh, unruly and chaotic noisescapes, through soft and subtly organized ticks and glitches, to dense spectral clouds that sometimes even produce fragmented melodies.[8] All these sounds, however, are produced by the channel, which is normally supposed to stay silent.

The purpose of a mixing board is to mix incoming signals together into a balanced and coherent whole. Although this process is by no means passive, in most recording or amplification scenarios (whether live or in the studio), it is not supposed to draw attention to itself in any way. The mixing board's operations should remain concealed by an output, which is to be presented to the listener as if the mixing process did not take place at all. A good mix should generally be as unobtrusive as possible. Nakamura's process, by contrast, highlights exactly those noises that are normally meant to remain hidden. In this way, he emphasizes that the transmission from sender to receiver is not effortless or transparent but produced by a series of channels that actively shape the signal. Drawing attention to what happens inside the black box, the no-input mixing board highlights the parasitic middle and exposes the logic of filtering that underpins all technologically (re)produced sound. "It is precisely under mediatic conditions," Kittler explained in an interview in 1992, "that what cannot be processed, what is impossible, is brought into ever sharper focus."[9] Nakamura's music is entirely produced by the random and irreducible artifacts of the channel itself, stripped of any pretense of the conceptual logic of noise reduction. This music, I claim, thereby effectively pulls this "sharper focus on that what cannot be processed."

In the case of pretechnical media such as alphabetic writing or Western music notation, symbolic signs (letters or notes) are almost completely

[7] "Toshimaru Nakamura/Sachiko M. Press Release from Erstwhile," *Erstwhile Recordings*, March 2001, accessed November 15, 2016, www.efi.group.shef.ac.uk/labels/erstwhil/erst013.html. See also Gabriel Paiuk's discussion of various musical practices in which "the use of lo-fi devices, circuit-bending, cracked electronics and a resurfacing of older technologies is coupled with digital technology in a process which emphasises the devices characteristic modes of sound production and artefacts." Gabriel Paiuk, "Tactility, Traces, Codes: Reassessing Timbre in Electronic Media," *Organised Sound* 18, no. 3 (2013): 306–313.

[8] "Nimb #8," track 8 on *No Input Mixing Board* by Toshimaru Nakamura, Zero Gravity, 2000, compact disc; "Nimb #25," track 3 on *No Input Mixing Board [3]* by Toshimaru Nakamura, *Alcohol*, 2003, compact disc; "NIMB 54," track 4 on *Re-Verbed (No-Input Mixing Board 9)* by Toshimaru Nakamura, Room40, 2018, compact disc.

[9] Friedrich Kittler, "Spooky Electricity: An Interview with Friedrich Kittler," by Laurence Rickels, *Artforum* (December 1992): 68. Accessed July 17, 2015, monoskop.org/images/2/29/Rickels_Laurence_Kittler_Friedrich_1992_Spooky_Electricity.pdf.

separated from the material noise of their physical production as signals (spoken language or sounding music). This separation—this clean cut—hides the reductive filtering operations that enabled the production and transmission of these signs in the first place. When a filter disappears behind the output's ostensibly unambiguous clarity, it seems to become almost completely transparent.[10] It supposedly disappears. A similar process is at work in the case of the ideal spectral filter posited by Fourier analysis. In introducing the Fourier integral to derive the spectral composition of nonperiodic signals, this filter creates an absolutely clear, discontinuous representation of all frequencies within a given time-interval, represented as a series of infinitely oscillating sine waves. Although this operation brings the spectral complexity of sounds into sharper focus, it does so only by removing or suspending all of their nonperiodicity and fundamental transience. The effortless, clean cut of an ideal filter, then, seems to conceal physical signals' fundamental fuzziness.

If we are to adhere to the conceptual logic of noise reduction, the output of technical filtering operations would always asymptotically tend toward the perfection produced by this ideal filter. Outputs will increasingly approximate, but never quite achieve, both the infinite oscillations of ideal sine waves and infinitesimal temporal exactitude of Delta functions. From the vantage point of the plane of the ideal filter, then, technological reproductions are always incomplete, impaired versions of these limit cases. Random traces of the technical cuts that produced the signal in the first place become reminders of technical media's inability to achieve absolute perfection. Attempts to implement idealized filtering operations in material hardware, however, bring the importance of the moment of filtering, the moment of the cut itself, into greater focus. Unlike the ideal scenario, the production of physical signals does not rest on the complete symbolic reduction of all noise of their material production. It relies instead on the basic rules of signal processing: that is, on physical cuts that leave transient traces in the signal's spectral composition and temporal flow.

As Nakamura's no-input mixing board shows, these traces of technical filtering operations are entirely brought forth by, and belong to, the channel itself. These sonic artifacts attest to something that, on the plane of the ideal filter at least, is supposed to be entirely absent (for the ideal filter's clean cut is meant to leave no traces whatsoever). As such, they confirm the irreducibility of the random, transient, stochastic, chaotic, and noisy elements that stick to the signal, which escape complete representation or analysis. Here, under the mediatic conditions of sound technology, "that what cannot be processed" is

[10] Siegert, *Techniques*, 20.

"brought into ever sharper focus": namely, the fundamental fuzziness produced inside the black box at the very moment a technical filter makes a physical cut.

The logic of noise reduction discursively construes a relation in terms of accuracy of representation or degree of faithfulness, between input and output, original and copy, based on the sonic difference caused by these artifacts of technical filtering operations. If we no longer take the representational clarity of the ideal filter as our primary point of reference, however, these categories (input and output, original and copy) cease being bound to idealizations that flatten the complexities of physical signal transmission. In this new perspective, the artifacts of technical filtering operations no longer mark outputs as always already incomplete, impaired versions of inputs—reminders of the impossibility of achieving absolute perfection. The logic of noise reduction's idealizations privilege periodic elements that can be processed, analyzed, represented, and pass through the filter unchanged. The logic of filtering, in contrast, highlights everything that cannot be processed unproblematically and is therefore affected by the operation of transmission itself. It highlights the ways in which physical cuts made by technical filters shape signals. And it shows that it is precisely physical signals' supposed "asymptoticity" (the fact that they are always tending toward the symbolic limit cases produced by an ideal filter) that defines their singularity.

No physical signal can ever match the limit cases produced by an ideal filter, however, for traces of its physical production as signal are inseparably inscribed in its sonic contours. It makes sense to call a signal "imperfect" or "incomplete" only in comparison to these imagined ideal limit cases. Considered on its own, though, a given signal is entirely itself and inherently different from all other signals—the "original" input included. In ensuring the singularity of each sonic moment, the transient traces of physical filtering operations bring the moment of filtering—of the cut itself—into sharper focus. The presence or "thatness" of a signal confirms that the filtering operation has taken place. As soon as its "whatness" or identity can be determined, analyzed, and processed, though, this presence has already passed. As such, the very moment of filtering itself—the instant of the cut—always escapes our perception. Only its sonic traces reveal that it ever took place. Nakamura's no-input music indicates this too. Although we are always too late to catch the cut as it happens, as Derrida would say, Nakamura's *Nimb* pieces consist entirely of sonic traces of the cut—of sounds that prove that a cut has taken place.

The logic of the no-input mixing board overturns the linearity in which output follows input and copy follows original. In place of such normative successions, it establishes a circular order, a feedback. In a feedback loop,

a channel's operations spin out of control and turn back on themselves. Resonating with itself in a closed loop, the channel's filtering function, normally concealed behind the output signal's seeming clarity, is revealed as the primary agent in technological sound production. As he only uses the circuitry of his mixing board, Nakamura's music underscores that the filtering channel always shapes the output in ways that cannot be fully controlled or repressed. Whether heard in the control room of a music studio or the comfort of one's own living room, while driving a car or dancing in a club, a signal that comes out of the loudspeakers at one end of the filtering chain is both radically different from, and fundamentally similar to, what went in. Radically different in the sense that its spectral contours and temporal flow are unique in comparison to those of the signal that "originally" went in. Fundamentally similar in the sense that what comes out is as physically real and sonically complex as any other sound.

Producing a New Sound

The logic of filtering supports the notion that recorded sounds are uniquely shaped by the sonic traces of each consecutive channel—each gate or passageway—in the transmission chain. In acknowledging the conceptual primacy of these instances of filtering in between input and output, it upsets the conventional view that an intrinsic, unbroken relation obtains between the two. Breaking this connection allows us to make better sense of what comes out of the speakers. This approach, which need not necessarily take into account what "originally" went in, benefits from a close yet critical look at Kittler's famous conceptualization of the gramophone in terms of the Lacanian real.

In *Gramophone, Film, Typewriter*, his most widely read book in the anglophone world, Kittler describes how these three nineteenth-century media technologies fundamentally reshaped how human beings make sense of the world. The book frames their influence in terms of "Lacan's 'methodological distinction' among the real, the imaginary, and the symbolic."[11] The typewriter, first, is based on discrete alphanumerical signs. As such, it structures written language as "a selection from the finite and arranged stock of its keyboard," which can be understood in terms of the symbolic.[12] Lacan's imaginary, second, regulates the subject's idealized mirror-image of their body

[11] Kittler, *Gramophone*, 15.
[12] Kittler, *Gramophone*, 16.

and, as such, "implements precisely those optical illusions that were being researched in the early days of cinema."[13] The real, finally, always escapes the grid of the symbolic and mirror of the imaginary. It can only be experienced as a lack and can never be represented or reproduced beyond its immediate effect in the here and now. It constitutes, in Kittler's words, "the physiological accidents and stochastic disorder of bodies."[14]

In information theory, such random accidents, stochastic disorder, and contingent events, are simply called "noise." The transition from what Kittler calls "discourse network 1800," defined by the reductive bottleneck of alphabetic writing, to "discourse network 1900," defined by technical media channels that directly store and reproduce physical signals, effected a change in the significance of this noise. Whereas in the former discourse network noise was that which is always excluded from symbolic representations such as written words and notated music, in the latter it became that which always remains in place or "sticks" to each physical reproduction (needle scratch, tape hiss, quantization errors).[15] This is why, Kittler argues, the operations of the gramophone can be understood in terms of the Lacanian real. Indeed, the gramophone "does not hear as do ears that have been trained immediately to filter voices, words, and sounds out of noise."[16] It does not construe symbolic meaning. Rather, it registers sounds indiscriminately of their origin or meaning.

In a recent essay, media philosopher Mark Hansen critically assesses Kittler's psychoanalytical take on the feedback loop between technical information channels and human sense-making. More specifically, he dissects the claim that the gramophone processes acoustic data without symbolic (human) encoding.[17] Whereas Kittler describes a transition from pretechnological media that operate on the level of the symbolic to technical media that process physical signals on the level of real, Hansen believes that all forms of representation and reproduction require symbolic reduction.[18] To be able to process physical signals and turn them into manageable information, he argues, both pretechnical and technical media rely on operations that filter symbolic data out from among a much more complex, entangled, and

[13] Kittler, *Gramophone*, 15.
[14] Kittler, *Gramophone*, 16.
[15] Kittler, *Discourse Networks*, 185–186. It is often noted that the English term "discourse system" does not do complete justice to the original German concept of "Aufschreibsystem," which literally translates as "writing down system" or "system for writing down."
[16] Kittler, *Gramophone*, 23.
[17] Mark B. N. Hansen, "Symbolizing Time: Kittler and the Twenty-First-Century Media," in *Kittler Now: Current Perspectives in Kittler Studies*, eds. Stephen Sale and Laura Salisbury (Cambridge: Polity Press, 2015), 210–237.
[18] Hansen, "Symbolizing," 220.

confused physical reality.[19] Fourier analysis, for instance, renders the physical world understandable, analyzable, and ultimately manipulable by breaking sound into small components, and symbolically modeling its physical properties in the form of quantifiable data.

If Hansen's assumption is correct, and all mediatic operations are ultimately predicated on similarly symbolic, alphanumeric representations, then the difference between the operations of pretechnical media and technical media is only a matter of degree. It does not, as Kittler argues, constitute a discursive break. Hansen claims that, regardless of the operational logic through which they are produced, all representations and reproductions are symbolically processed versions of their input, which "only get asymptotically closer to the real they symbolize."[20] As they filter information out of the real, which in itself remains unrepresentable, media technological operations produce what Hansen calls the "symbolic of the Real."[21] What sound reproductions lack, Hansen argues, is exactly what Kittler claims they capture: all of the continuous and contingent characteristics of the original input signal. For Hansen, then, the filtering operations of media—whether symbolic or physical—assure that neither sound reproduction nor any other medium can actually store, reproduce, or manipulate the real.

In arguing that technological reproductions are, by definition, based on symbolic reductions of physical reality, Hansen's interpretation of Kittler supports the idea that reproductions are inherently imperfect and incomplete. They always only tend toward or "get asymptotically closer" to, but never fully coincide with the "real they symbolize." However, in relegating all mediatic operations to the domain of the symbolic, this analysis inadvertently upholds the idealist conception of the connection between input and output, according to which the latter can only be understood as an incomplete version of the former. My conceptualization of the logic of filtering, however, stresses that the output signal's supposed "asymptoticity" is not the result of technological reproduction's inability to represent or reproduce the input signal. Instead, an analysis of the operations of the filtering channel itself shows that what technological reproductions "asymptotically" tend toward is not the "real" of the "original" input signal, as Hansen assumes, but rather the symbolic limit cases produced by the symbolic model of representation—that is, the timeless spectral clarity suggested by Fourier analysis or absolute temporal exactitude of the Dirac impulse.

[19] Hansen, "Symbolizing," 230.
[20] Hansen, "Symbolizing," 233.
[21] Hansen, "Symbolizing," 233. Emphasis in original.

On the one hand, then, Hansen rightly argues that technical sound media do not store or reproduce the Lacanian real as such. After all, according to Lacan's own definition, the real cannot be experienced, expressed, or represented at all. It appears only as a shock or sudden apparition, jutting momentarily through cracks in the imaginary and symbolic, like a flash of lightning that briefly brightens an otherwise dark sky during a thunderstorm. The "real" of a spatiotemporal event—defined by its singular contingency and infinite detail—remains fundamentally unrepresentable and inaccessible beyond itself. On the other hand, Hansen's alternative category of the "symbolic of the Real" implies an intrinsic relation between input and output, according to which the latter symbolically represents the former. As such, it also assumes the ideal of a total (symbolic or physical) reduction of sonic traces of the technical filtering channels that lie between them.

Hansen erroneously equates the symbolic analysis of media technological processes with their physical implementation in material hardware. Once again, this confusion is most apparent in relation to digital technology. By symbolically excluding analog switching operations and the noise they generate, digital sound sampling turns the "thatness" of temporal events into the "whatness" of objects. Based on the implementation of Fourier analysis—more specifically, the Fast Fourier Transform used by digital computers—each of these objects, or rather time-limited samples, stores the spectral information of a physical signal at the expense of its temporal flow. True, Hansen observes that digital technology indeed "allows for a symbolization of the temporal flow on a far finer scale" than either alphabetic symbolizations or human sensory perception. Nevertheless, when digital signs are transduced back into electrical currents, and from electrical currents into acoustic signals, their symbolizations re-enter physical reality, and become subject to the unrepresentable contingencies that define everything that takes place in the real.[22] When digital representations are turned into physical sounds, for instance, symbolic quantization errors become acoustic distortion—the digital equivalent of analog noise. As with noise reduction in analog media, the application of dither decorrelates this distortion as a means of disguising the gap between the ideal (symbolic) representation and technical (real) reproduction.

Hansen rightly observes that this concealing of the channel's operations, which is meant to reveal a fully clear signal, is fundamentally symbolic: it is entirely predicated on suppressing the channel and idealizing the input signal. Still, although the analytical models through which the representation or

[22] Hansen, "Symbolizing," 228.

reproduction of this whatness of sound become possible do indeed belong to the symbolic, the thatness of the sound signals going into and coming out of the chain of filters (the sounds that one can actually hear) fundamentally belongs to the real. In other words, the periodic, explicatory "whatness" of the analytical models and brief "thatness" of the acoustic event relate to each other as the symbolic to the real. No matter how closely the output matches the input, signals produced by physical filters between these two ends of the chain are unique sonic events in and of themselves. The sounds emanating from speakers or headphones might be more or less similar to the signals that went in, but unlike words in books, notes on paper, or images on canvas or celluloid, they are always just as nonsymbolically complex and singularly "real."

This means that the visceral impact and significance of the sounds listened to in recording studios by musicians, producers, and engineers; the sounds coming out of speakers and headphones all over the world, which listeners relate to and cherish; the sounds that pass through long chains of parasitic filters, cannot be understood as performing a "symbolization of the temporal flow," as Hansen would have it. Contra Hansen, I hold that it does make sense to discuss the process of sound reproduction in terms of the Lacanian real, albeit in a way that differs from Kittler's account as well. If the real is indeed impossible and unrepresentable, then the randomness and contingency caused by attempts to resolve the uncertainty principle cannot be fully analyzed or processed. Hansen casts this impossibility as an inability to fully represent the real, a confirmation of technical media's inherently symbolic status. By contrast, I argue that exactly the transience and randomness, which form part of neither the "original" input signal nor an ideal analytical model, allows for an understanding of technical media in which all sonic traces of the real, whether noise, distortion, transience, or randomness, are crucial. These sonic traces of filtering processes—of the physical cuts that produced the sound in the first place—emphasize that input and output constitute entirely different instantiations of the real.

At the moment of capture, sound technology carves complex waves away from the flow of time and stores them acoustically, electromagnetically, or digitally on a hardware medium. At the moment of playback, these data are turned back into sounds, which include the sonic traces of the chain of filters that lie between human musicians and human listeners. These traces always have escaped, and always will escape, full analytical control. Because they are concrete, physical, manipulable, and real, technologically (re)produced sounds do not represent anything beyond themselves, anything that they do not already embody themselves. Through the traces of

their own production, however, they "speak," in Kittler's McLuhian phrase, "of what is done by sounds."[23] Here, Kittler does not posit an always already intrinsically meaningful connection between music and listeners, based on a delineated symbolic code and its congruent meanings. Instead, he foregrounds relations among technological sounds and human listeners comprising flows of complex, contingent, and unpredictable physical sound signals.[24]

Across the history of recorded music, these sonic traces of the material production of sound—the traces of physical filtering operations—have increasingly taken center stage. Although music produced by technical media is still directed toward human ears, it is no longer concerned with symbolic sense-making through interpretative sign systems. Accordingly, supposedly intrinsic meaning and human agency—those cornerstones of the nineteenth-century paradigm of written music—have become increasingly arbitrary.[25] Raw sound data produced by technical filtering operations take shape independently of the meanings or interpretations intended by human composers and musicians. As a result, the ways in which these sounds become meaningful to listeners is no longer intrinsically related to what originally went in—let alone to some extramusical, metaphysical referent beyond physical sound altogether. Due to this emphasis on physical sound, there is something compulsive about music produced on the basis of the technical logic of filtering. Something that goes beyond the symbolic ordering processes directed by human subjects, something that works on us and controls us instead of the other way around. Precisely this compulsive dimension of technological sound reproductions, I argue, marks the irrepressible presence of the real.

[23] Kittler, "God," 13. As Rudolf Maresch puts it, "sound is already its content. Sound only conveys itself." Rudolf Maresch, "Waves, Flows, Streams: Die Illusion vom Reinen Sound," in *Soundcultures: Über Elektronische und Digitale Musik*, eds. Marcus S. Kleiner and Achim Szepanski (Frankfurt am Main: Suhrkamp, 2003), 206. On a less conceptual note, Paul Théberge writes that in popular music "the term 'sound' has taken on a peculiar material character that cannot be separated either from the 'music' or, more importantly, from the sound recording as the dominant medium of reproduction." Paul Théberge, *Any Sound You Can Imagine: Making Music/Consuming Technology* (Hanover: Wesleyan University Press, 1997), 191.

[24] Friedrich Kittler, "Musik als Medium," in *Wahrnehmung und Geschichte: Markierungen zur Aisthesis Materialis*, eds. Bernhard Dotzler and Ernst Martin Müller (Berlin: Akademie Verlag. 1995), 99.

[25] Regarding the increasing influence of nonhuman agents and growing importance of the physical sound of music in the age of technical media, Peter Szendy writes that "operations 'external' to the musical (to so-called 'pure' music) are now endowed with the ability to create signifying segments in the course of the music's flow." Peter Szendy, *Listen: A History of Our Ears*, trans. Charlotte Mandell (New York: Fordham University Press, 2008), 135. In addition, Rudolf Maresch argues that " 'sound' as such only emerged with the electronic revolution, which began in Old Europe about a century ago. Only with that development, on the margins of musical notation, it became perceptible by the human ear." Rudolf Maresch, "Waves," 205.

An "Other Music"

With the influence of physical cuts made by technical filtering operations, a new sensibility took hold of contemporary musical cultures. This technological mode of sound production has broken with the system of symbolic representation and signification that defined Western music for centuries. Across writings spanning four decades, Kittler consistently calls this musical sensibility an "other music." This music "no longer derive[s] its power from alliances with the medium of language and its 'meanings,'" but is governed instead by "pure media-technology" or "pure control flow."[26] As such, it leaves behind the Western, anthropocentric, subject-based, and representational concept of music, which developed in tandem with increasingly sophisticated forms of musical notation, and many centuries of music theory and philosophy. The "other music" is no longer based on such symbolic reductions and ideal filters. It operates on a plane in between the autonomous processes that take place inside the material channels of technical media and the aesthetic significance that human listeners attribute to musical sounds. It works through the production, transmission, and manipulation of physically present, complex sound signals by technical filtering operations.[27]

According to Kittler, the first signs of this "other" musical sensibility emerged in the second half of the nineteenth century. Major advances in acoustics (culminating in the publication of Helmholtz's *On the Sensations of Tone*) brought the physical properties of sound itself to the fore and began to replace age-old representational concepts of music. Slowly but surely, the supposedly "clear" distinction between musical sounds and all other sounds and noises became increasingly arbitrary.[28] Ever the quintessential German, Kittler claims that this shift first became apparent in Richard Wagner's music dramas. He writes that Wagner, in using the orchestra to sonically approximate the spectral and temporal complexity of natural sounds, "truly wrote out the noise-source called nature."[29] Certainly, Wagner's singers and orchestra remain bound to the twelve tones of the Western diatonic scale and its corresponding notational system. Nevertheless, according to Kittler, they do not interpret the music but operate as an acoustical "machine" that reproduces rather than represents natural sounds.[30] They produce Foley

[26] Kittler, "Musik als Medium," 99.
[27] Kittler, "Musik als Medium," 99.
[28] Friedrich Kittler, "'Vernehmen, Was Du Kannst': Über Neuzeitliche Musik als Akustische Täuschung," *Neue Zeitschrift für Musik* 158, no. 5 (1997): 7.
[29] Kittler, "Vernehmen," 7.
[30] Kittler, "Vernehmen," 8.

sound avant-la-lettre. Kittler argues that sounds in Wagner's music dramas—from the approximate Fourier series in the form of an E-flat major chord in the overture of *Das Rheingold* to the "pure noise" that accompanies the downfall of the gods at the end of *Götterdämmerung*—represent nothing but themselves.[31] This is why, for Kittler, Wagner's music dramas prefigure the "other music," in which sounds no longer symbolically represent something outside of the sonic domain. When sounds simply are what they are, music no longer requires such hermeneutic interpretation.

Wagner's orchestral machine anticipated the ways in which sound technologies differ from traditional musical instruments. In sound reproduction technologies, the manual labor of human agents is subordinate to technical filtering operations. These latter bring forth and shape sounds without human subjects symbolically filtering them (attributing cultural "meaning" within the context of some predetermined musical logic) in advance. When sounds are recorded and pressed on vinyl, burned on CD, or uploaded to the cloud, the listener only has to plug in a pair of speakers or earphones and press play for a chain of parasitic filters to autonomously produce sounds that can be repeated time after time after time. The physical presence of the "other music" has no need for additional symbolization, for its sounds only "speak of what is done by sounds." As such, it puts an end to the idea that musical sounds should represent anything that they are not already. True, in many cases human musicians still play instruments (whether acoustic, electronic, or digital) and human engineers still control the transmission of signals as best they can, by meticulously placing microphones, pulling cables, turning knobs, and switching switches. Regardless of the number of human actors involved, however, everything that happens inside the cables and black boxes along the transmission chain maintains a level of randomness and contingency. The singular sounds produced by these technological filtering processes, these physical cuts, constitute the "other music."

Whereas infinitely ideal filters would produce entirely noiseless signals, the moment of the physical cut negates such clarity. Like Derrida's click of a photographic shutter, the filter cannot produce unambiguous information about what the signal is at that precise moment it takes place. The sonic traces of the moment of the cut therefore emphasize that the filter produces new sounds time and time again. Although technical media enable ever more advanced possibilities for both symbolic representation and technological reproduction, the more advanced they become, the more they highlight the fundamental unrepresentability and inaccessibility of this moment of the cut. This

[31] Kittler, "Musik als Medium," 96.

double-sidedness of technical sound reproduction is foreshadowed in a passage on "the south in music" from Nietzsche's *Beyond Good and Evil*, which originally inspired Kittler's notion of the "other music."[32] Although Kittler claims that when it came to the "other music," Nietzsche "knew only Wagner," in fact Nietzsche placed special emphasis on the "southern aspect" of Georges Bizet's opera *Carmen*.[33] In stark contrast to "the 'late Wagner' and his *Parsifal* music," Nietzsche writes, the "southern" music of Bizet inspires the dream of a

> more profound, more powerful, perhaps more evil and more mysterious music, a supra-German music which does not fade away, turn yellow, and grow pale at the sight of the blue voluptuous sea and the brightness of the Mediterranean sky.[34]

This emphasis on southerly brightness in music can be understood in terms of Nietzsche's influential distinction between two cultural impulses: the Apollonian (encapsulating the visual, rationality, and order) and Dionysian (incarnating music, feverish embodiment, and indistinction). Indeed, in *Nietzsche and Music*, Georges Liébert notes that around the time Nietzsche was writing *Beyond Good and Evil*, "Apollonian images and visual metaphors become more and more frequent" in his work, indicating that he was "looking, contemplating, open to the forms that the light reveals to him against an azure background or sharp shadows."[35] Once, Nietzsche had admired the "'harmonic fog' of Wagner's orchestra" above all else. Now, it had come to represent the dark, northerly, and Dionysian, against which Nietzsche posed the light, rationalist, and Apollonian transparency of Bizet's music. Liébert cites a passage in Nietzsche's *Ecce Homo*, in which the philosopher praises the "absolute transparency of [Bizet's] woven counterpoint, the utilization of each instrument in terms of its specific coloration, in the voice that is most natural and fitting to it."[36] Taking account of this duality, according to which sounds are divided between light and dark, Apollonian and Dionysian, southern and northern, one begins to see how Kittler's concept of the "other music," which is marked by the duality between ideal and technical filters, was inspired by Nietzsche's "more profound, more powerful, perhaps more evil and more mysterious music."

[32] Friedrich Nietzsche, *Beyond Good and Evil: Prelude to a Philosophy of the Future*, trans. Ian Johnston (Arlington: Richer Resources Publications, 2009), 173.

[33] Kittler, "God," 12. Nietzsche's disillusionment with Wagner and infatuation with Bizet is laid out in more detail in *Nietzsche Contra Wagner* (1889). See also Georges Liébert, *Nietzsche and Music*, trans. David Pellauer and Graham Parkes (Chicago: University of Chicago Press, 2004), 198–202.

[34] Nietzsche, *Beyond*, 173, 176.

[35] Liébert, *Nietzsche*, 197.

[36] Nietzsche in Liébert, *Nietzsche*, 200.

On the one hand, in embodying Apollonian form, clarity, and order, the sounds of the "other music" do "not fade away, turn yellow, and grow pale" in comparison to natural sounds. Inscribed on the hardware of technical media, they can be repeated over and over again, sounding "just as rich, colorful and bright as nature itself" every time.[37] Indeed, in dislodging the primacy of subjective human agency, the "other music" does not symbolically represent, but physically reproduces what Kittler calls the infinite and continuous "noise source" called nature. On the other hand, however, this reproduction also tends toward the dark and uncontrollable Dionysian side of Nietzsche's music philosophy. Whereas the "brightness of the Mediterranean sky" recalls Derrida's moment in the Greek summer sun (the ideal, infinitesimally short moment at which "we are infinite . . . eternally"), the fundamental inaccessibility of this moment is like the dark shadow cast by the light of that summer sun.[38] It emphasizes the inherent unrepresentability of the present in its infinite presence. After all, the "noise source called nature" cannot be captured or reproduced in full, for physical filters cannot capture the inextricable complexity of the event at the very moment it occurs. This is why the colorful and bright sounds of the "other music" are ultimately new sounds, which, in turn, keep slipping from our control.

Influenced by communication engineering as much as musical aesthetics, by acoustics as much as music theory, and by technical media's physical filters as much as subjective and symbolic human filters, the "other music" is profoundly split. On one side is a sharp Apollonian focus on the physical nature of sound, determined by the combined legacies of mathematical analysis, theoretical physics, and communication engineering from the nineteenth century onward. On another is the Dionysian unrepresentability of the very moment that enables this focus in the first place: the inaccessible moment of filtering that is inevitably defined by the uncertainty relation between time and frequency. The "other music," in short, is created by technologies that supposedly reproduce singular acoustic events, but actually end up producing sounds that are always singularly themselves. This is because the "original" singular acoustic events are affected by the unrepresentable operations of the channel itself during this process of reproduction, giving rise to altogether new, unique sounds. The "other music," in short, is not *re*produced but produced by the information channels of sound media.

[37] Kittler "Vernehmen," 7.
[38] Derrida, *Athens*, 63.

In the closing paragraph of an essay titled "The God of Ears," in which the idea of an "other music" first appeared, Kittler explains the agency of technical media in producing new and unexpected sounds:

> Even a heart attached to contact microphones and oscilloscopes becomes still. And when, with loud and quiet, light and dark, Heaven and Hell, all differences disappear, another realm (possibly known as Satori by other cultures) is coming closer. The media explosion of our days, therefore, should not only be heard in the media-theoretical manner of its prophets. According to Marshall McLuhan, the message of the synthesizer is simply the synthesizer. But even if the darkness is so overwhelming that no dark side of the moon exists, electronic media might yet invoke a still darker presence.[39]

What does this mean? Serres suggests that the introduction of a parasite into a system causes differences to appear, creating distinctions between input and output, sound and noise, wanted and unwanted signals. Were the influence of such parasites annulled, it follows that these differences would disappear. This would be achieved, for instance, by an ideal filter, which symbolically reduces the difference between input and output to zero. Sonically, this complete reduction of noise would produce ideal, infinite sine waves. A place in which "all differences disappear," then, would bear a strong resemblance to the Fourier domain, in which strictly periodic sine waves oscillate unchanged into eternity. Processed by operations that go beyond human perception, the output signals of technical sound media continuously tend toward the clarity of ideal filters, reaching beyond the clouds and inescapable transience of life. This tending toward perfect order and clarity is in keeping with the profoundly human wish to either halt or at least fully capture the flow of time. In the context of sound reproduction, this wish would entail resolving the dilemma of the time/frequency uncertainty relation and overcoming the gap between representation and represented. In this desired universe, every copy would fully coincide with its original and every output would be identical to the input.

This idealist dream, however, is tempered by the notion that signals only come asymptotically close to their so-called originals. Both original and copy only infinitely approximate the absolute purity produced by the ideal filter, tending toward the infinitesimal point-like presence of Dirac impulses and the ideal spectral filter of Fourier analysis. Through this fundamental asymptoticity of technological signals, determined by the logic of filtering, the

[39] Kittler, "God," 16.

"darker presence" of the "other music" becomes apparent. This asymptoticity is the result of the inescapable singularity or, as Kittler puts it "unfathomable stochastics" produced by the cuts of technical filters.[40] Acknowledging the primacy of this moment of physical filtering serves to highlight the middle ground that lies between the extremes of Kittler's "we are immortal" and Derrida's "we are infinite." In this middle ground—in the domain of technical filters—the fundamentally asymptotic sounds produced by technical filtering operations resonate emphatically with human listeners, who are themselves asymptotic subjects that never fully coincide with their imagined selves. Rather, they continuously tend toward, or rather long for, temporal extremes without ever actually achieving either a pure indivisible instant at which "we are infinite," or the great repetitive beyond in which "we are immortal." Because of this, we dream of machines that could overcome the dichotomy: ideal media that would enable real-time signal transmission in perfect, infinitesimally detailed resolution, capturing the minutiae of each transient event without temporal delay.

Encapsulating this dream of ideal media, Kittler's mention of a "heart attached to contact microphones and oscilloscopes" refers to the sound that bookends Pink Floyd's multiplatinum record *The Dark Side of the Moon*—one of the most successful albums in the history of recorded music. Since they were recorded some time in 1972, these approximately hundred beats have sounded billions of times, emanating from speakers and headphones all over the globe again . . . and again . . . and again . . . and again . . . . The sound of a beating heart might forebode its inevitable silence (Heidegger's "indefinite certainty"). With the aid of sound technology, however, even this most precarious of all bodily sounds can be repeated over and over again, extending its potential lifespan well beyond the average 2.5 billion beats performed by a human heart.[41] Every time a sound is repeated, writes Kittler, "time stops, what more do hearts want?"[42] Given the chance, hearts want to beat forever. It might seem that technical media, which outlive the things or people they record, might deliver on this techno-religious dream of immortality.

[40] Kittler, "God," 15.

[41] Since its release in 1973, *The Dark Side of the Moon* sold approximately 50 million copies. With a hundred heartbeats per copy, this amounts to 5 billion heartbeats. If, over the course of the past 43 years, each of these records has been played a minimum of five times (not taking into account illegal copies, online streaming services, radio plays, and other sources) the song has already equaled the average 2.5 billion heartbeats of a human life. Given the record's lasting popularity, it is safe to assume the actual number is much higher. As David Wills writes about the sound of one's own heart: "in every nonbeat or offbeat of the heart, in every flutter or murmur, there resides, if we listen, the irreducibly necessary possibility of stopping beating." David Wills, "Positive Feedback: Listening Behind Hearing," in *Thresholds of Listening: Sound, Technics, Space,* ed. Sander van Maas (New York: Fordham University Press, 2015), 87.

[42] Kittler, "Lightning," 68.

As it turns out, however, the sound at the beginning and end of *The Dark Side of the Moon* is not a recording of a human heart "attached to contact microphones and oscilloscopes" at all. Instead, it is a "simulated heartbeat, looped from a recording of [Pink Floyd drummer] Nick Mason's bass drum."[43] The sound is not a reproduction but an imitation. The distance between this imitated heartbeat and a recording of a real human heart illustrates the conceptual relation between ideal media's promise of perfect reproduction and the darker presences that define the "other music." Although sound media allow for the endless repetition of any sound, human hearts will ultimately become still, whether or not they are "attached to contact microphones and oscilloscopes." It may be that the signals produced by technical sound media asymptotically tend toward a clarity through which one might master time and death. However: the cuts made by their physical filters, which produce such signals in the first place, continuously escape our control. Absolute clarity and control remain forever out of reach. Every time we press play, therefore, the transience of sound's physical unfolding in time remains absolute. The ideal realm, in which all differences, delays, and deferrals disappear, can only be reached by leaving behind the finite temporality of existence altogether.

The "other music" is marked by transience in the form of noise and distortion, which resonate in the ears and brains of human listeners over and over again. Listening to this noise of sound means listening to the sonic residue of the real's unrepresentable and irreproducible complexity, which shapes the temporal transience and spectral singularity of all sonic events just as it defines the fundamental transience of our bodies. The noise of material channels, which inscribes itself unceasingly on the physical signals they transmit and produce, continuously evades our analytical grasp. For this reason, such noise remains a fundamentally inaccessible, an unrepresentable part of the present's acoustical flow. Even the most fine-grained digital sieve cannot process sonic events in all their singular temporal and spectral complexity. With each transduction from physical sound to digital data and back into physical sound again, the noises and distortions produced by filtering rear their head, causing an essentially new, singular sound to emerge.

[43] John Harris, *The Dark Side of the Moon: The Making of the Pink Floyd Masterpiece* (Cambridge, MA: Da Capo Press, 2005), 141. Concerning the recording of the "heartbeat" on *The Dark Side of the Moon*, drummer Nick Mason recalls in his autobiography that: "Initially we had tried creating the heartbeat that opens the piece from hospital recordings of real pulses, but all of them sounded far too stressful. We returned to the possibilities of musical instruments, and used a very soft beater on a padded bass drum, which strangely sounded far more lifelike, although the average heartbeat rate of 72 bpm was too fast and we slowed it down to a level that would have caused any cardiologist some concern." Nick Mason, *Inside Out: A Personal History of Pink Floyd*, ed. by Phillip Dodd (San Francisco: Chronicle Books, 2005), 169.

Regardless of the method of production, recording, storage, transmission, or playback, then, musical sounds that come out of speakers or headphones are as physical and nonsymbolic as any other sound. Their impact relies not on the ideal purity of perfectly delineated representational models, but on the sheer physical presence of sound waves, which are always more complex and contingent than these symbolic representations. This is why Kittler argues that sound media do not represent nor reproduce a so-called input signal, but rather produce "unforeseeable, unthinkable, unimaginable acoustic events."[44] Technologically produced acoustic events are singularly marked by traces that belong to neither the original input nor an ideal model. Rather, they are the sole preserve of the of filtering channels in between. As such, they are unforeseeable in that they showcase the same amount of temporal contingency as any other sound; unthinkable in that they do not result from any rational compositional process; and unimaginable in that they do not require human creativity to affect the listener.

Ultimately, at the end of the recording and reproduction process, the final filter, the listener's brain, transforms these physical sounds into emphatic music. The "other music" therefore emerges when all the sonic traces of all the transient events that occurred along the chain of transmission channels physically resonate in the human listeners' ears. When unforeseeable, unthinkable, and unimaginable sounds flow seamlessly from speakers or headphones, the inconceivable presence of the real cracks through the surface. Physically unfolding in the acoustic present, but discursively connected to the past, the randomness of noise resonates with the "darker presence" of the unrepresentable real. Not by providing access to it, but by bringing its unrepresentability into ever sharper focus.

[44] Kittler, "Tanzmusik," 40.