

Sound, Knowledge, and the “Immanence of Human Failure”

*Rethinking Musical Mechanization through the
Phonograph, the Player-Piano, and the Piano*

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At the dawn of the twentieth century, the emergence of a new technology for the mechanical reproduction of music struck many people in the United States as a harbinger of dramatic cultural change. To its champions, this technology would usher in a more democratic musical age, bringing “good” music to more people, more easily, untethered from the painstaking and time-consuming labor of learning to play the piano. For some, this held the promise of fighting back what they saw as the degenerative, corrupting effects of the rising tide of popular music. A few contemporaries championed this new technology of mechanical reproduction for its creative potential in and of itself, capable perhaps of opening new realms of musical expression. Others, meanwhile, found the technology a menace, debasing the time-honored value of traditional musical training and robbing copyright holders of their rightful compensation for their creative labors. This technology was called the player-piano.

The player-piano has not aged well. Today, it seems like a curious mechanical stopover on the route from manual music making to digital storage and playback. To the extent that it is remembered at all, it is usually cast as a historical also-ran, a postscript to the age of the piano, a foil to the more dramatic advent of the phonograph. Yet the culture of the mechanical reproduction of music does not belong to the phonograph alone. To wit, in 1900, by which time both the phonograph and the player-piano were widely known, many more people saw the player-piano as a revolutionary cultural

force and the phonograph as a mere trifle than the other way around. It is a myopic view of history that sees only the triumph of the phonograph and the fading of the player-piano. In the formative years of what Douglas Kahn has called the “century of sound,” the two technologies emerged in tandem, both resting on a deeper history of musical mechanization.¹ The cultural and commercial development of the phonograph was to a significant extent inseparable from that of the player-piano, and the myriad questions—legal, cultural, phenomenological—raised by recording and mechanical reproduction were generally associated with not one but both technologies. For example, in the congressional hearings that led to the landmark Copyright Act of 1909, which formed the basis of U.S. copyright law for most of the twentieth century, player-pianos and phonographs factored into the discussions on relatively equal terms, and the final law, which established the doctrine of “mechanical rights” for the payment of royalties on recordings of copyrighted musical material, was crafted to take both technologies into account. If the legacy of the Victrola has been more historically conspicuous, we would do well to remember that its name was a deliberate play on Pianola, the trademarked design of the leading player-piano company.

None of this is to belittle or deny the importance of the phonograph, but rather to suggest a thicker, more multifarious account of the historical development of sound recording and the modern soundscape of capitalism. Music lies at the center of this reinterpretation, because music has had an especially large effect on the form and meanings of the mechanical reproduction of sound generally.² In the era of mechanically reproduced sound, the political economy of music rested on the player-piano and the piano, as well as on the phonograph. Scrutinizing the latter, theorists such as Theodor Adorno, Jacques Attali, and Friedrich Kittler have done much to draw out the deep interconnectedness of music, sound, technology, and power.³ They, along with a growing number of historians and other scholars, have shown that listening is a culturally constituted practice, with both a politics and an ethics.⁴ Too strict a focus on the phonograph has serious consequences, however. It obscures a broader, deeper, more complex set of changes of which the mechanical reproduction of sound was a part.

Indeed, the political economy of sound recording looks different if we include the player-piano in our purview. Rather than a linear path of development, it suggests a dialectical progression, based in equal measures on the objectification of time and the rationalization of knowledge, the former based in the phonograph, the latter in the player-piano. Through the player-piano, moreover, we may recognize not just the epochal rupture wrought by the advent of sound recording but also its connection to a longer, more evolutionary history of music and capitalism. If today we swim in a sea of recorded music, the modern culture of recorded sound

must not be understood merely as the inexorable effect of the invention and development of the phonograph, however important that technology has been. Historicizing the player-piano also has something important to teach us, demonstrating the interwovenness of the two technologies and the complementary ways that they have informed the construction of and reactions to modernity.

Records and Rolls: Historicity, Data, and Aura

But what is a sound recording—and what is it that the mechanical reproduction of music reproduces? These questions lie at the heart of a provocative and thoughtful article by Eric Rothenbuhler and John Durham Peters, “Defining Phonography: An Experiment in Theory,” analyzing what they see as an important historical break between the age of older sound-recording technologies and the advent of digital sound media. In their argument, “phonography” encompasses all “analog” formats of sound recording, from cylinders and discs to magnetic tape, united by a common indexical quality. That is, despite their apparent differences, each is a kind of inscription that serves “as one link in a chain of direct connections across time and space.” In addition, they are specifically sonic technologies, designed and developed to record and transmit sound. In these respects and others, Rothenbuhler and Peters maintain, phonographic media stand in marked contrast to digital technologies, designed and developed not as sound media but as technologies to store and transmit binary data—ones and zeros—that could just as easily refer to text, images, mathematical formulas, or other forms of data. As such, Rothenbuhler and Peters argue, digital media function (merely) as sign systems, no longer as actual traces of the past, and are thereby denuded of a connection to physical and social human experience.⁵

Their argument, as I read it, is strongest on the issue of historicity: the audibility not just of the past but of the passage of time. “Analog recording retains the otherness of past time,” they write. The physical objects that store and convey such recordings embody the sounds’ historical course. A vinyl LP record that has been played a hundred times sounds different—with its pop, clicks, and surface noise—than one whose historical journey has been shorter or less momentous. The stylus is like a plow in the furrows of the past, churning up sounds long since buried. Each time the needle is set into the groove, the auditor bears witness to a physical connection between the past and the present. Analog recording weds the ephemerality of bodies and sounds to enduring objects, and through such objects historical contiguity becomes an “axis of cognition.” This bridge to the past is possible because phonographic media make audible not one history but two: that of the recording and that of the record. Digital media, by

contrast, share none of the traits of physical embodiment. The aural character of such media is limited to a single dimension (i.e., binary data) and refuses to yield traces of its own passage through time. When the surface of a CD is marred by dirt or scratches, either it works or it does not; “the data encoded on the CD do not mix with the history of the disk.”⁶ (Rothenbuhler and Peters’s article predated the everyday use of computer files as a music medium, but their arguments generally apply to these, too.)

Although the work of Walter Benjamin does not enter Rothenbuhler and Peters’s discussion, their ideas about phonographic historicity offer a helpful explanation for Benjamin’s near silence about the phonograph in his essay “The Work of Art in the Age of Mechanical Reproduction,” one of the major theoretical reference points for a discussion such as theirs. Benjamin mentions the phonograph only twice and has little to say about sound generally in his essay. The reason for this may have less to do with his particular tastes and intellectual proclivities than with the uncomfortable fit that the phonograph has with his argument about “aura.” Focusing on photography and cinema, Benjamin argued that works of art lost their unique “aura” when they were created by and conveyed through technologies of mechanical reproduction.⁷ It would seem, however, that phonograph records are incompatible with this claim, because they, if we accept Rothenbuhler and Peters’s argument, retain something that closely resembles Benjamin’s idea of aura (albeit without the hierarchical social relations that Benjamin maintained attended to painting and theater).

More problematic, however, is Rothenbuhler and Peters’s historical schema, which posits that the regime of digital sound media, based on the storage and conveyance of data, breaks sharply with the past. On the contrary, the “new” technology of computers builds directly on the binary principle of player-pianos, whose perforated paper rolls anticipated many of the basic elements of digitization. This claim applies to both the common form of the instrument, often referred to generically as a *pianola* (just as *victrola* became a synonym for phonograph), and to the more complex form, which was called a *reproducing player-piano*. With pianolas, each hole in the piano roll indicated simply where a piano key was to be played and where it was not. With reproducing player-pianos, the perforated roll encoded not merely the notes to be struck but also all aspects of how to play them—including tempo, phrasing, dynamics, pedaling, and so on.

Some limitations notwithstanding, then, reproducing piano rolls were recordings par excellence. Indeed, until the late 1920s, this technology could record and reproduce a piano performance far better than the phonograph, and even today, under most conditions and even with high-end audio equipment, recordings sound like recordings, not like reanimations of some original acoustic event. That is, one is unlikely to mistake a sound recording, whether analog or digital, for the performance

of a live human musician; a recording of a piano, for example, will simply not reverberate in a room the same as the playing of an actual piano. By contrast, a reproducing piano roll generated sounds far closer to those made by the original pianist, whether it was Ignacy Jan Paderewski or a moderately skilled hack working for one of the player-piano companies.⁸ (Opportunities to hear reproducing player-pianos are rare today, but the effect is similar to hearing MIDI-controlled musical instruments: one is hard-pressed to differentiate such a performance from a live rendering.) Reproducing player-pianos carried a much higher price tag than pianolas and phonographs and never made up more than 12 percent of the player-pianos produced at a given time,⁹ but they constituted a prominent and established dimension of musical culture in the second and third decades of the twentieth century and complicate a narrative of the development of sound recording that proceeds linearly from analog to digital, from sound-based to data-based.¹⁰ Indeed, they undermine a central tenet of Rothenbuhler and Peters's argument about the dichotomy between analog and digital, because the reproducing player-piano was very much both.

The Deep Roots of Musical Mechanization

It bears emphasizing, as well, that a great deal of the commentary about the changing sound culture in the early twentieth century included both technologies within its purview. In some cases, a magazine article on one of the new technologies brought the other into its discussion,¹¹ or in other cases, as in the debates over the revision of the copyright law, the phonograph and the player-piano were linked as two aspects of a single phenomenon. When the Copyright Act of 1909 was finalized, the law drew no distinction between the two technologies, treating both as examples of mechanically reproduced copyrighted works. Likewise, John Philip Sousa's well-known article from 1906, "The Menace of Mechanical Music," which is usually read as a jeremiad against "canned music" but whose underlying purpose was really to generate support for copyright reform, also grouped the phonograph and player-piano together.¹²

For Sousa to characterize player-pianos and phonographs as machines was no doubt accurate, but the real significance of the new technologies must lie beyond this fact, because all musical instruments are in essence machines. Indeed, music has been "machine-ridden," Jacques Barzun has written, since "the moment man ceased to make music with his voice alone."¹³ Rather, more important was that the phonograph and player-piano were particular kinds of machines, developed in a particular time and place, standing in particular relation to the broader development of modern Western society. The significance of this fact comes increasingly into focus as we place the phonograph and player-piano in deeper historical

perspective, especially with regard to the piano. As Max Weber noted, a careful study of the forms, structures, and technologies of Western music reveals a set of values and tendencies bearing the deep imprint of the social and rational development of capitalism itself.¹⁴ Indeed, all musical instruments may be machines, but in the annals of the world's music, only the modern West has had a musical culture centered upon a complex machine. "In China, Japan, India and the Arab world," observes historian Geoffrey Hindley, "the classic instruments of the elite music philosopher—*ch'in*, *koto*, *vina*, and *'ud*—are simple lutes or zithers," but starting in medieval Europe, the quintessential instrument of the West "has been an elaborate keyboard mechanism—organ, harpsichord or piano."¹⁵

Although Weber did not discuss the phonograph or the player-piano, his analysis of the piano suggests an important way to understand the imbrication of prevailing social and economic ideas in musical forms and technologies. The piano both represented and embodied the bourgeois social order, forming the bedrock of the musical culture on which both the phonograph and player-piano were founded. Proceeding by homology (rather than explicit causality), Weber notes that piano culture developed not where and when the piano was invented (in Italy, in the early eighteenth century) but in the industrializing regions of northern and western Europe and eventually North America, whose populations were more "house-bound and home-centered" than those of southern Europe and whose climates were better suited to keeping the instruments in tune (especially before the development of iron-framed instruments). It helped, as well, that unlike organs, which sounded best in large, cavernous spaces, the piano achieved its optimum sound in a room of modest size, like the bourgeois parlor.

The development of the culture of the piano, however, depended not just on the conditions of consumption but also those of production, and only a technologically and industrially advanced society could develop and manufacture such a machine. When Jonas Chickering's iron-framed pianos appeared at London's Crystal Palace Exhibition in 1851, they were hailed as the zenith of American industry, and two years later, when his firm opened the doors of its new factory, the building was reported to be the nation's single largest industrial building and the second largest building overall, after the U.S. Capitol in Washington.¹⁶ The history of the piano, wrote the eminent music critic Ernest Newman, was "the record of an incessant piling up of mechanism."¹⁷ The instrument's growing popularity, therefore, was inseparable from the rise of industrial manufacturing, much as would later be true of the phonograph, which was born inside the first professional research and development laboratory and whose commercial production depended on what was called the "American system of manufactures." "This machine," Thomas Edison wrote of the phonograph in 1878, "can

only be built on the American principle of interchangeability of parts, like a gun or sewing machine.”¹⁸

Even more than the piano and the phonograph, it is the player-piano that best symbolizes the close relation between music machines and industrial manufacturing—and not just by homology. Although the player-piano’s oldest antecedents probably lay in the water- and air-powered organs of antiquity, its clearest modern precursors were the numerous styles of barrel organs and music boxes that were crafted in Europe from the seventeenth to the nineteenth century. The player mechanism in the player-piano resembled these earlier devices, but rather than being programmed by a fixed rotating drum with protruding pins or pegs, its musical notes were indicated by a continuous, interchangeable, perforated paper roll. The forerunner of this design was a system based on perforated cardboard sheets, patented in 1842 by Claude-Félix Seytre, a mechanical engineer from Lyon, whose design was modeled on the famous Lyon silk looms of Joseph-Marie Jacquard. Early in the nineteenth century, Jacquard invented a system to program his looms using a series of interlaced punched cards. But what inspired Jacquard’s design? His system was based on the ideas of Jacques de Vaucanson, the famous maker of automata and previous owner of Jacquard’s looms, who had devised a punched-card system for automating his looms in the 1740s. The ideas of Vaucanson, in turn, drew on those of Jean-Baptiste Falcon, who had programmed his looms using individual perforated cards in the late 1720s. At the beginning of this chain of manufacturing innovation, though, we find music: the inspiration for Falcon’s design was Basile Bouchon, a textile worker and son of an organ maker, who in 1725 fashioned a system to control his looms using a perforated paper roll, a design he modeled specifically on the control of musical automata by pegged cylinders.¹⁹ Musical technology, in other words, helped inspire the automation of industrial manufacturing, which then returned to inspire musical technology.

Jacquard’s punched cards inspired more than the player-piano, however. Charles Babbage drew on them in the 1830s in the design of his “analytical engine,” a landmark conceptual forerunner of the modern computer. In reality, Babbage’s work was more influential theoretically than practically, but later, the application of the music roll/punched-card idea returned in the work of Herman Hollerith, who devised a revolutionary system for automating the tabulation of the 1890 U.S. Census. Hollerith studied both the Jacquard and player-piano systems in detail, and player-piano rolls became his model for the coding of sequences.²⁰ His system opened up vast new possibilities in quantitative processing, and in 1896, he founded the company that in 1924 became the International Business Machines Corporation (IBM). Moreover, as IBM became one of the leading developers and promoters of modern computing technol-



Figure 1. At the IBM exhibit at the World's Fair in Seattle in 1962, a giant hand-cranked music box taught children that modern computers utilized the same basic principles as old-fashioned music machines. *IBM Stockholders' Quarterly Report*, 11 July 1962. Courtesy of the IBM Corporation

ogy, it did not lose sight of the computer's musical antecedent. The firm's exhibition at the 1962 Seattle World's Fair used a large music box, which visitors could operate, to explain to the public how computers worked (figure 1). The company's quarterly report to stockholders explained the purpose and value of this display: "[The] machine . . . illustrates how stored mathematical information in a modern computer's memory is based on the same general principle as stored musical information in an old-fashioned music box. As the music box's cylinder is turned, spikes projecting from its surface release their information in the form of a song."²¹

Beyond player-pianos and computers, the connection between music, machines, and modernity comes still further into focus if we take seriously the idea that musical instruments are tools for making something, even if in this case the "something" is sound, not a material product. If all musical instruments are in essence machines, what happens if we view the piano in the broad historical shift from hand- to machine-based production? According to Marx, the shift from manual to machine-based production began when a mechanism first performed "with its tools the same operations that were formerly done by the workman with similar tools."²² Whether the motive power of the machine was human, electrical,

or pneumatic was irrelevant; what mattered was that the tool itself was “taken from man and fitted into a mechanism.” This shift underwent an important advance when the motion of the tool or task was given a fixed path by the structure of the machine. As Harry Braverman noted in his classic study *Labor and Monopoly Capital*, what was crucial about this for the organization of labor and production was not that the fixed, regular motions of the device were automatic but that they were predetermined. He cites as examples a drill press, a lathe, and a sewing machine, all of which were based on a fixed motion but which were not necessarily automatic.²³ The same tendency can be seen in a piano. A piano produces eighty-eight regular pitches and only those pitches, and it produces them easily and predictably. In contrast, a violinist must produce each note him- or herself, and a fundamental part of the violinist’s skill is finding and forming each note, easily and quickly. With a piano, on the other hand, even the most unskilled operator can walk up to a keyboard and hit a perfect middle C.

Braverman’s analysis is particularly helpful in explaining mechanization not as a single, integrated phenomenon, but as a multistage process, spread across a spectrum and progressing by degree. Although mechanization is often associated with deskilling or the degradation of labor, Braverman points out that at early stages in the process, mechanization can actually enhance a producer’s skill, not undermine it. A cabinet maker’s work was improved by the drill press and the lathe, not degraded by it, and the same might be said of a pianist, for whom the keyboard became a means of unprecedented musical control. Granted, of all the pitches in the universe, the piano limited the composer to these eighty-eight, but these could be arranged and played in an extraordinary range of ways. Indeed, a virtuoso could use this machine to produce works far beyond what was possible with only simpler tools or with no tools at all and could consolidate the labor of many other musicians. As Franz Liszt described the piano: “In its seven octaves, it embraces the compass of an orchestra, and our ten fingers suffice to reproduce the harmonies created by an ensemble of one hundred musicians. . . . We can play broken chords as on the harp, long sustained notes as on wind instruments, staccati, and thousands of passages that would once have been possible only on other instruments.”²⁴

Meanwhile, the musical education of pianists, opposed to that of composers, generally focused on standardized execution and submission to the authority of the composer’s score. As one of the leading music educators of the nineteenth century, Adolph Kullak, put it in the concluding paragraph of *The Aesthetics of Pianoforte-Playing*, “Pianoforte playing is primarily a *reproductive* art only, the exposition of its subject-matter requires the highest degree of education on the part of the interpreter” (emphasis in original).²⁵ This stage of mechanization presupposed an extremely high degree of skill, but the point of the player’s labor was, just as it would be

later with increasingly mechanized technologies, reproduction of sounds determined earlier, by someone else.

The player-piano and phonograph appeared further along the spectrum of mechanization, with growing amounts of control and skill now shifting from the operator to the machine. Increasingly, the knowledge and skill of production were relocated inside the mechanism, and human participation was reconfigured as the operator of a machine. It is worth noting, however, that these devices did not represent the endpoint of mechanization, for they did require some degree of operator involvement—choosing which musical selections to play, pumping a player-piano’s foot pedals or winding up a phonograph, adjusting the speed and volume, and so on. Such practices were not, of course, creative forms of labor on the order of conventional piano playing, but they involved more knowledge and input than technologies that were developed even further along the spectrum: reproducing player-pianos, whose paper roll controlled all pianistic and sonic effects, not merely the notes; radios; more recently, the iPod Shuffle, whose users cede control of selecting which songs will play; and programmable clock radios, which, once programmed, no longer depend on human labor to start (and often stop) making music.

At some point, the objection could be raised that player-pianos still do not belong in the same class of devices as phonographs because the former is limited to piano music and the latter can encompass music of all kinds. Such arguments weaken, however, when the history of piano music and the actual content of early phonograph records are taken into account. The phonograph was not the first instrument to have a vast musical range, and its repertoire, like that of the player-piano and piano, was based on adaptations. As Liszt suggested, the piano was an instrument of seemingly endless versatility and power, and its protean ability to imitate and assimilate other instruments made it possible to bring into the home many musical works and styles of music not originally intended for private living spaces. This “domestication” was particularly evident in “four-hand” piano arrangements (i.e., for two pianists, sitting side by side), which adapted for the parlor everything from liturgical music and opera to minstrel shows and large-scale orchestral works.²⁶ As Max Weber noted, one of the primary factors accounting for “the unshakable modern position of the piano” in Western musical culture was “the universality of its usefulness for domestic appropriation of almost all treasures of music literature.”²⁷ Thus, in various published adaptations, piano music encompassed a tremendous range of idioms, and later, the practice of creatively adapting many musical styles for the keyboard continued and expanded with the advent of the player-piano. Admittedly, the versatility of the phonograph exceeded even that of the player-piano, but the phonograph’s vast sonic offerings were neither unprecedented nor unique.

Moreover, like the piano and the player-piano, the phonograph, too, was an instrument of adaptations. Musical arrangements for the keyboard sometimes had to suffer dramatic modifications, and the same was true for phonograph recordings. Because cello and double-bass parts did not record well, for example, they were often replaced by tubas and trombones. Further, records *represented* music, Lisa Gitelman has noted, in ways that could likewise be considered forms of adaptation: “‘Band’ records were actually recorded by small ensembles representing bands; recorded musical pieces were short segments or pastiches representing whole compositions; comic sketches were two-minute records representing whole fifteen-minute vaudeville ‘turns’; and the earliest [commercial] recordings were announced and even occasionally applauded, representing live performances.” Given these many factors, it is difficult to maintain the argument that player-pianos offered only a narrow and parochial range of “piano music,” in contrast to the more exhaustive and less mediated offerings of the phonograph.²⁸

Meanwhile, another characteristic that linked the piano, the player-piano, and the phonograph was that all three used some form of inscription to adapt a wide range of sound to their respective media. With the piano, music was written into the dots and lines of musical notation; with the player-piano, inscription took the form of perforations in a paper roll; with the phonograph, sound was inscribed into a spiral groove on a cylinder or disc. Regarding the phonograph, Adorno wrote, “Music, previously conveyed by writing, suddenly turns itself into writing.”²⁹ To some extent, this remark applies to player-piano rolls, too, although the latter also required an additional form of inscription: a certain amount of editing by hand after the recording. Taken together, however, what distinguished the player-piano and phonograph from the piano was that only a machine was capable of reading the “writing” on which the player-piano and phonograph depended. Although it strained commonsense notions of writing and reading to attribute such behavior to machines, writing and reading were in essence what these technologies did, a recognition of which ultimately prevailed in law. Initially, in an important copyright infringement case, *White-Smith v. Apollo* (1908), the U.S. Supreme Court rejected the idea that a piano roll was a kind of writing if no human could read it. The following year, though, Congress arrived at the opposite conclusion in the course of overhauling the copyright code; to have done otherwise would have denied that piano rolls and phonograph records were copies of copyrighted material.³⁰

If both the player-piano and phonograph were forms of inscription, they diverged in what they inscribed — and this divergence illuminates the complementary ways the two technologies contributed to the underlying constitution of modern society. The phonograph inscribed and conveyed

sound-in-time—that is, sound as the ephemeral vibrations in the air produced by a specific instance of musical labor (or other sound-making activity). The player-piano, by contrast, represented a system of sound-in-knowledge—that is, information and instructions on how to make music. It inscribed and conveyed how to perform, over and over, the labor required to produce certain predetermined sounds. In this respect, more than a century before the age of MP3s, the technology of the player-piano was essentially indistinguishable from the modern digital computer, whose basic, underlying properties Alan Turing outlined in his famous article “Computing Machinery and Intelligence.” Turing compared a human computer (i.e., a person who computes) with a machine and argued that the latter had to have three characteristics in order to reproduce/automate the (mental) labor of the human: (a) it must have a “store” of knowledge, (b) it must be able to execute some function based on that knowledge, and (c) it must function only within the limits of some preset controls.³¹ The player-piano satisfied such criteria; drawing on a predefined body of knowledge, it generated music according to sequences of discrete decisions that led to the execution of a series of discrete actions.

By contrast, although phonograph records certainly functioned as a store (as a young Adorno noted with some optimism³²) and operated within evident controls, phonographs reproduced vibrations, not actions based on human knowledge. Thus, between the phonograph and player-piano, the mechanical reproduction of sound encompassed two divergent, complementary aspects of modernity. The phonograph added to the radical reconfiguration of experiences of time and space, a metaphysical transformation to which many innovations contributed, including those in transportation (e.g., railroads), communications (e.g., the telegraph and telephone), visual representation (e.g., photography, cubism), psychology (e.g., Freud), philosophy (e.g., Bergson), and physics (e.g., Einstein’s theory of relativity, Heisenberg’s uncertainly principle).³³ Indeed, as Barbara Engh has argued, it may even be said that the phonograph altered what it meant to be human (as Roland Barthes said of photography).³⁴ In counterpoint with the phonograph, the valence of the player-piano was the rationalization of knowledge, labor, and culture, especially in terms of the growing tendency toward quantification, mechanization, automation, and digitization. The fact that the phonograph and player-piano emerged at the same time, as mutually reinforcing phenomena, therefore problematizes an easy binary of analog and digital and a neat narrative of one prefiguring the other.

William Gaddis and the Rationalization of Culture

Beyond the 1920s, the significance of the player-piano has been difficult to perceive. This is attributable less to the marginal importance of the player-piano than to the conspicuous and inescapable impact of the phonograph and its offshoots. From this perspective, the player-piano may look only like a relic, a trace of a transitional moment in our musical and technological past. This is how it has most often been seen by scholars.³⁵ To a few writers, however, the player-piano has represented something more revealing—and lasting. Kurt Vonnegut, for example, in his debut novel, *Player Piano* (1952), used the instrument as an ironic symbol of a mechanized near-future dystopia in which engineers were the only valued members of the workforce, with technological unemployment having rendered virtually all other workers redundant. The titular player-piano factors into the plot only marginally, but it echoes through the novel as a leisure-time symbol of the mechanization and displacement in the workplace, a transformation whose effects were social and psychological as much as economic.³⁶

The player-piano figured more substantially in the work of William Gaddis. Born in 1922, just as the instrument's star was fading, Gaddis is best known as a novelist, but he worked for many years on a critical cultural history of the player-piano. He had begun thinking about the instrument as the result of a fact-checking assignment for the *New Yorker* in the early 1940s, and he died in 1998 without ever bringing the book to completion.³⁷ His deep, ongoing work on the project, however, figured prominently in two of his five novels, and the archive of his personal papers, deposited at Washington University in St. Louis, contains much of his accumulated research. Indeed, it might be said that Gaddis's opus on the player-piano was the most penetrating, far-reaching history of the instrument never to be written. If music, machines, and money were all part of the fabric of American society, Gaddis sought to scrutinize the tightness of the weave that bound them together, the fibers from which each strand was spun, and the complex way they held each other in place. As with Vonnegut, player-pianos themselves were not really Gaddis's concern. Rather, it was how the development and proliferation of these instruments undermined, as the critic Ed Park put it, "the possibility of art under the sign of commerce."³⁸ In the broadest sense, the player-piano was, for Gaddis, a means to understand and explain something much bigger, the formation and effect of modernity itself. Indeed, his was an interpretation of late capitalism grounded not only in the increasing resemblance of art and commerce, both of which had become thoroughly mechanized, but also in the historical, structural, and practical ways that art and commerce had become linked.

The first of Gaddis's published books to incorporate his work on the player-piano was *JR*, his second novel, which appeared in 1975.³⁹ Earning for Gaddis the first of his two National Book Awards, this mammoth and demanding tour de force chronicles the rise and fall of an eleven-year-old tycoon, the eponymous JR. Throughout most of the novel, the pint-sized venture capitalist remains out of view, however, and the plot's development focuses instead on other characters, the most important of whom share connections to music and the player-piano business. The first of these characters is Edward Bast, a young, hapless composer who gets roped into serving as JR's professional surrogate and who embodies the mundane struggle of the artist in modern capitalist society—teaching music to schoolchildren on a corporate grant, scoring music for a corporate PR film, and trying to pick up extra money working for the American Society of Composers, Authors, and Publishers (ASCAP), which employs him simply to listen to the radio for the broadcast of unlicensed music. Through his family, Bast embodies the dual character of music as industrial and cultural production. The family business, run by his uncle, had been a successful manufacturer of piano rolls and later punch cards. By contrast, his father was a reasonably successful conductor and composer. Edward is pulled between the worlds of art and business, trying desperately to make his way as a composer but repeatedly getting sucked back into JR's business dealings. These conflicts constitute the book's primary plot. Meanwhile, its secondary story line, which frames JR's machinations, concerns the attempt to settle the estate of Bast's recently deceased uncle, who, for technical reasons, may have been Edward's legal father, underscoring the uncertainty of the young composer's worldly orientation.

In his work at the school, Bast meets Jack Gibbs, a former engineer-inventor at the Bast family's piano roll company who has for years labored on a long, complex critical history of the player-piano. (The book includes a facsimile of Gaddis's own notes as an illustration of Gibbs's exhaustive work.) Through Gibbs, Gaddis then articulates his essential views on the transformation of art and society, a tension set in relief by a sign once seen by Oscar Wilde in a Colorado saloon in the 1880s: "Please do not shoot the pianist. He is doing his best."

Posted in a Leadville saloon, this appeal caught the eye of art in its ripe procession of one [traveling] through the new frontier of the 'eighties where the frail human element still abounded even in the arts as Oscar Wilde alone, observing the mortality in that place [as] marvelous, passed on unrankled by that phrase doing his best, redolent of chance and the very immanence of human failure that [a] century of progress was consecrated to wiping out once and for all; for if, as another mother country throwback had it, all art does constantly aspire to the condition of music, there in a Colorado mining town saloon all art's essential predicament threatened to be laid bare with

the clap of a pistol shot just as deliverance was at hand, born of the beast with two backs called arts and sciences whose rambunctious coupling came crashing the jealous enclosures of class, taste, and talent, to open the arts to Americans for democratic action and leave history to bunk.⁴⁰

Thus, art declined in proportion to the elimination of risk. As “chance” and the “immanence of human failure” were “[wiped] out” by “progress,” the “enclosures of class, taste, and talent” left no room for the danger and uncertainty on which real human art rested. With this in mind, Wilde characterized the sign he saw—“Please do not shoot the pianist. He is doing his best”—as “the only rational method of art criticism I have ever come across.”⁴¹ For Gaddis, risk was the sine qua non of art, while the player-piano, with its predetermined outcomes and detachment from active human involvement, was art’s antithesis. The “immanence of human failure” was not a problem to be solved but rather a precondition of art’s very existence.

The title of both Gibbs’s and Gaddis’s work-in-progress was “Agapē Agape: A Secret History of the Player Piano,” which, minus the subtitle, became the name of Gaddis’s last novel, published posthumously in 2002.⁴² With ideas and allusions ricocheting at a dizzying pace, this short, dense book tracks the ideas and feelings of a dying man, among whose greatest preoccupations is his unwieldy and unfinished history of mechanization in the arts. Even more than *J R*, this book suggested the historical richness and complexity of Gaddis’s project, its allusions careering from physicist Willard Gibbs (namesake of *J R*’s Jack Gibbs) to cybernetic theoretician Norbert Wiener to pioneering cultural historian Johann Huizinga. As both an heir to Jacquard’s looms and a forerunner of supercomputers, the player-piano refracted the mechanization and rationalization occurring throughout society, as well as modeling how those phenomena had penetrated and undermined the arts.

Ultimately, Gaddis saw so many affinities and connections between the player-piano and myriad contemporary forms of social and economic rationalization that he was overwhelmed by the burden of integrating these phenomena coherently and characterized the project as “a casualty of over-research.”⁴³ The density and complexity of the matrix in which Gaddis saw the player-piano embedded is suggested perhaps by an excerpt from his unpublished nonfiction work, which appeared in a posthumous collection of Gaddis’s shorter writings:

Analysis, measurement, prediction and control, the elimination of failure through programmed organization, the player [piano] emerged as a distillation of the goals that had surrounded its gestation in an orgy of fragmented talents seeking after the useful, Rockefeller organizing this world as Darwin the last one and Mrs. Eddy the next, Pullman organizing people and Spies

labor, Eastman and McCormick patents and parts, Woolworth cash and Morgan credit, Frick power with his own property and Insull with other people's, Gibbs physics, Comstock vice, and Hollerith the census, while Spencer programmed ethics and Freud the psyche, Taylor work, Dewey facts, James things, Mendel, Correns, Tschermak and De Vries and De Vries, Tschermak and Correns heredity, a frenzied search for just those patterns in communication and control that were even then not only transporting Frank Woolworth's damaged musical faculty "hatless, dishevelled and gay" in Ride of the Walküres to the mighty Halls of old Walhalla, but carrying all the people rather than the patrician classes toward the utopian equilibrium of John Stuart Mills's stationary state, where the stream of human industry will "finally spread itself out into an apparently stagnant sea."⁴⁴

Evidently, Gaddis was traveling some of the same ground as Weber, but he went slightly further than Weber, who had great insight about the piano and about capitalism but was silent about the player-piano (although it was in wide circulation by the time he was writing).⁴⁵ For Gaddis, the player-piano was at its core an instrument of what Marxists would call primitive accumulation and alienation. Its proliferation contributed to the separation of people from the means of (cultural) production and to the process by which people were made foreign to one another and to themselves. To mask such injurious effects, however, the player-piano was promoted as a vehicle for cultural "democracy"—a nineteenth-century notion about which Gaddis harbored profound suspicions. ("Here's Flaubert," Gaddis writes in *Agapē Agape*: "The entire dream of democracy is to raise the proletariat to the level of bourgeois stupidity."⁴⁶)

To some extent, Gaddis's claims are self-evident and irrefutable. From the perspective of the production of culture, mechanical reproduction did introduce a divide between production and consumption and did, in many cases, supplant the manual, aural, and cognitive skills required of conventional music making. But as a cultural critique of mechanical reproduction, Gaddis's analysis took at face value that mechanization had only one, devastatingly negative kind of aesthetic impact. Gaddis assumed that mechanical reproduction was a priori at odds with the goals of art. In the eyes of some composers and critics, however, the mechanical devices held aesthetic possibilities. For these people, whom we might think of as idealists or aestheticists, the essence of music resided in composition; performance, in their view, because it always had a degree of idiosyncrasy, was only a necessary evil. In the 1920s, the German critic and musicologist H. H. Stuckenschmidt hailed a new age of mechanical music, which he believed would enable composers, through piano rolls and phonograph records that they would make themselves, to communicate directly with auditors, without suffering the mediation and distortion of uncertain performers. (Forty years later, Glenn Gould expressed a similar hope,

imagining that recording and editing performances on magnetic tape might enable him to collapse the distance between the auditor and Bach himself.)⁴⁷ Along similar lines, in the 1910s and 1920s composers Igor Stravinsky, Paul Hindemith, Ernst Toch, and others approached the player-piano as a novel tool of musical expression—that is, as a means to create new sounds not available through conventional composition and manual instrumentation. This more open-ended approach to the instrument recalls one of the subtle insights of Braverman’s critical analysis of mechanization: that at early stages, machines could enhance a laborer’s skill. For a cabinet maker, a lathe or drill press opened up new productive possibilities; it was an aid, not a threat.

The greatest of these experimentalists, however, was undoubtedly Conlon Nancarrow, whose breathtaking compositions for the player-piano from the 1940s to 1970s earned for him a place in the front ranks of avant-garde composers. In more than forty composed “studies” for the player-piano, Nancarrow created works of seemingly impossible piano sounds, played faster and with more notes than any human could execute, in intersecting rhythmic patterns of vertiginous, mathematical complexity that showered auditors with cascading waves of sound. In Nancarrow’s hands, the piano roll became a new expressive medium, for he was not only doing something novel with the player-piano, but also devising and exploring an entirely new musical idiom. Indeed, it is no small irony that, in 1982, when William Gaddis was awarded a MacArthur “genius” prize, one of the other recipients of the prize that year was Conlon Nancarrow. The player-piano deeply informed the work of both men, but in contrast to Gaddis’s high modern conservatism, Nancarrow was an avowed leftist. Born in Texarkana, Arkansas, he joined the Communist Party in 1933 and fought against Franco as part of the Lincoln Brigade in the Spanish Civil War. When his American passport was revoked as a result of his political activity, he moved to Mexico City, where he lived until his death in 1997. His compositions, all of which were instrumental, were not overtly political, but they belong to a tradition of political optimism about the relationship between art and mechanical reproduction, visible in everything from Walter Benjamin’s writings to Aleksandr Medvedkin’s cine-trains. Gaddis’s critique of the player-piano in the political economy of culture was sophisticated and compelling, but it was also static. Nancarrow and his experimentalist predecessors demonstrated that musical recording, at least as far as the player-piano was concerned, could have multiple aesthetic (and political) valences.⁴⁸

The emergence of sound recording in the twentieth century was both an evolutionary and revolutionary phenomenon. In the sense that player-pianos and phonographs were machines that made music, they extended a process that had begun millennia earlier. Indeed, for all the ways that the

phonograph and player-piano departed from nineteenth-century and earlier musical culture, they also continued and expanded the piano-centered practice of adapting a wide range of music for the keyboard, making available in the home, in adapted form, a vast range of musical styles and works. Although the phonograph broadened this access even beyond that which the player-piano could convey, in the formative period of modern recording culture, up to the late 1920s, the piano, which was the standard-bearer of Western musical technology up to that time, was one instrument whose sounds the phonograph did not capture well. On the other hand, the player-piano and phonograph were not just machines, but also particular kinds of machines, with a particular relation to the rapidly changing social and economic order. The historical timing of their appearance and the details of their discursive and technological identities were neither trivial nor coincidental. The conception, design, manufacture, and proliferation of these technologies modeled and reinforced the organization, conventions, and values of industrial production and modern consumer marketing. Much is to be gained by recognizing that today's digital technology itself has a musical history, revealing the ways that music and the development of modern computer technology, from Babbage to Herman Hollerith to Napster, have long been intertwined.

In the end, both Gaddis's and Nancarrow's visions of the player-piano have been borne out in notable ways. As Gaddis maintained, the player-piano symbolized and materialized the growing cultural importance of mechanization and automation, and it did so in particularly subtle and telling ways, expanding the practices and values of mechanization into the realm of consumption and into the aesthetic domain of the arts. Such effects notwithstanding, however, Nancarrow and those who composed for the player-piano before him ensured that the impact of the player-piano would not be one-dimensional. By engaging actively and directly with the technology, they swept aside its nominally mimetic character—the implication that it would convey only existing forms of music. Like Henry Cowell's *Aeolian Harp*, John Cage's pieces for prepared piano, and, later, the groundbreaking experimental turntablism of Grandmaster Flash, Christian Marclay, and others, the composers for player-piano intervened in the process of technological acculturation, radically reimagining what the mechanical technology of the player-piano was for and how it could be used. In so doing, they called attention to the technology and the character of recording itself, setting in relief the normative expectations and prevailing assumptions of manufacturers, marketers, and consumers. Certainly, the player-piano could represent the alienation of human labor, the standardization of aesthetic experience, and the reduction of a kind of human risk essential to the nature of art, but so too could it stand for mechanization's hidden possibilities.

Notes

1. Douglas Kahn's designation of the "century of sound" is based on the variety of important sound-related developments that took shape in the twentieth century, including the "maturation of phonography and telephony, [and the advent of] microphony, amplification, sound film, incidence of radio, television, synthesis, acoustical engineering, virtuality, and so on." See Douglas Kahn, "Track Organology," *October* 55 (1990): 71.

2. See David Suisman, *Selling Sounds: The Commercial Revolution in American Music* (Cambridge, MA: Harvard University Press, 2009).

3. Theodor Adorno, "The Curves of the Needle," *October* 55 (1990): 48–55; Theodor Adorno, "The Form of the Phonograph Record," *October* 55 (1990): 56–61; Jacques Attali, *Noise: The Political Economy of Music*, trans. Brian Massumi (1977; Minneapolis: University of Minnesota Press, 1985); Friedrich A. Kittler, *Gramophone, Film, Typewriter*, trans. Geoffrey Winthrop-Young and Michael Wutz (Stanford, CA: Stanford University Press, 1999). See also Evan Eisenberg, *Recording Angel: Explorations in Phonography* (New York: McGraw-Hill, 1986).

4. On listening, see, for example, David Goodman, "Distracted Listening: On Not Making Sound Choices in the 1930s," in *Sound in the Age of Mechanical Reproduction*, ed. David Suisman and Susan Strasser (Philadelphia: University of Pennsylvania Press, 2010). On the phonograph, see, for example, Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction* (Durham, NC: Duke University Press, 2002).

5. Eric W. Rothenbuhler and John Durham Peters, "Defining Phonography: An Experiment in Theory," *Musical Quarterly* 81 (1997): 242–64. "Phonography" defined at 261n1; quotation on 255.

6. *Ibid.*, 254, 255, 258.

7. Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in *Illuminations*, ed. Hannah Arendt, trans. Harry Zohn (New York: Schocken, 1968), 217–52. The references to the phonograph appear on pages 221 and 248 (note 13). Most of the other references to sound appear in relation to cinema. For example, on page 232: "The shooting of a film, especially of a sound film, affords a spectacle unimaginable anywhere at any time before this."

8. Even reproducing rolls were imperfect reproductions, however; all rolls underwent a postproduction process of editing, by hand, to compensate for errors, distortions, or slight imperfections in the recording process.

9. The peak recorded year for production of reproducing player-pianos was 1923. See U.S. Bureau of the Census, *Biennial Census of Manufactures: 1925* (Washington, DC: Government Printing Office, 1928), 1066.

10. Reproducing player-pianos are quite rare today, but they are regularly demonstrated in places like London's Mechanical Music Museum, where their effect remains powerful (to judge by the reaction of an audience when I visited). In recent years, recordings of some reproducing player-piano rolls have been reissued on CD. See, for example, George Gershwin, *The Piano Rolls*, vols. 1–2 (Nonesuch, NON 79287 and 79370); and the numerous volumes of the *Masters of the Piano Roll* series, issued by the Dal Segno label.

11. See, for example, Arthur Whiting, "The Mechanical Player," *Yale Review* 8 (1919): 828–35.

12. John Philip Sousa, "The Menace of Mechanical Music," *Appleton's Journal* 8 (1906): 278–84. On the relation of Sousa's article to the copyright reform law, see Suisman, *Selling Sounds*, 150, 163–65.

13. Jacques Barzun, quoted in Eisenberg, *Recording Angel*, 176.
14. Max Weber, *The Rational and Social Foundations of Music*, trans. Don Martindale, Johannes Riedel, and Gertrude Neuwirth (Carbondale: Southern Illinois University Press, 1958), 120–24. See also Max Weber, “Value-Judgments in Social Science,” in *Max Weber: Selections in Translation*, ed. W. G. Runciman (Cambridge: Cambridge University Press, 1978), 95–96.
15. Geoffrey Hindley, “Keyboards, Crankshafts, and Communication: The Musical Mindset of Western Technology,” in *Music and Technology in the Twentieth Century*, ed. Hans-Joachim Braun (Baltimore: Johns Hopkins University Press, 2002), 33–34.
16. *The Jonas Chickering Centennial Celebration* (New York: Cheltenham, for Chickering and Sons, 1924), 11; Cyril Ehrlich, *The Piano: A History* (Oxford: Clarendon, 1990), 27.
17. Ernest Newman, *The Piano-Player and Its Music* (London: Richards, 1920), 18.
18. Thomas Edison, quoted in Andre Millard, *Edison and the Business of Innovation* (Baltimore: Johns Hopkins University Press, 1990), 75.
19. Albert N. Link, *Technological Change and Productivity Growth* (New York: Harwood, 1987), 67.
20. Garry Wills, *Certain Trumpets: The Call of Leaders* (New York: Simon and Schuster, 1995), 124; William Rodgers, *Think: A Biography of the Watsons and IBM* (New York: Stein and Day, 1969), 69; Mark J. P. Wolf, *Abstracting Reality: Art, Communication, and Cognition in the Digital Age* (Lanham, MD: University Press of America, 2000), 37.
21. *IBM Stockholders’ Quarterly Report*, 11 July 1962, p. 4, in William Gaddis Papers, Washington University Library, St. Louis.
22. Karl Marx, *Capital*, vol. 1, trans. Samuel Moore and Edward Aveling, ed. Frederick Engels (New York: International, 1967), 374. On Marx and piano players, see also Raymond Williams, *Marxism and Literature* (New York: Oxford University Press, 1977), 93.
23. Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1975), 188–89.
24. Franz Liszt, quoted in Kurt Blaukopf, *Musical Life in a Changing Society: Aspects of Music Sociology*, trans. David Marinelli (Portland, OR: Amadeus, 1992), 62. In *Swann’s Way*, Proust’s Mme. Verdurin strikes a similar note after hearing her son’s rendition of a piano sonata: “You never dreamed, did you, that a piano could be made to express all that? Upon my word, you’d think it was everything but the piano! I’m caught out every time I hear it; I think I’m listening to an orchestra. Though it’s better, really, than an orchestra, more complete.” Marcel Proust, *Swann’s Way*, trans. C. K. Scott Moncrieff and Terence Kilmartin (New York: Vintage, 1982), 231. On the piano as a labor-saving device, see Edward J. Dent, “The Pianoforte and Its Influence on Modern Music,” *Musical Quarterly* 2 (1916): 272.
25. Adolph Kullak, *The Aesthetics of Pianoforte-Playing*, 3rd ed., trans. Th. Baker, ed. Hans Bischoff (New York: Schirmer, 1893), 328.
26. James Parakilas, “Music to Transport the Listener,” in James Parakilas et al., *Piano Roles: Three Hundred Years of Life with the Piano* (New Haven, CT: Yale University Press, 1999), 195–96; Thomas Christensen, “Public Music in Private Spaces: Piano-Vocal Scores and the Domestication of Opera,” in *Music and the Cultures of Print*, ed. Kate Van Orden (New York: Garland, 2000), 67–94.
27. Weber, *Rational and Social Foundations of Music*, 123–24.

28. Lisa Gitelman, *Always Already New: Media, History, and the Data of Culture* (Cambridge, MA: MIT Press, 2006), 69.
29. Adorno, "Form of the Phonograph Record," 59. See also Lisa Gitelman, *Scripts, Grooves, and Writing Machines: Representing Technology in the Edison Era* (Stanford, CA: Stanford University Press, 1999).
30. Lisa Gitelman, "Reading Music, Reading Records, Reading Race: Musical Copyright and the U.S. Copyright Act of 1909," *Musical Quarterly* 81 (1997): 265–90.
31. A. M. Turing, "Computing Machinery and Intelligence," *Mind*, n.s., 59 (1950): 436–39.
32. Adorno, "Form of the Phonograph Record," 58–61. Adorno was twenty-four when this essay was originally published in 1927.
33. See Anthony Giddens, *The Consequences of Modernity* (Stanford, CA: Stanford University Press, 1990); Stephen Kern, *The Culture of Time and Space, 1880–1918* (Cambridge, MA: Harvard University Press, 1983).
34. Barbara Engh, "After 'His Master's Voice,'" *New Formations* 38 (1999): 54–63.
35. Two recent exceptions include Lisa Gitelman, "Media, Materiality, and the Measure of the Digital; or, The Case of Sheet Music and the Problem of Piano Rolls," in *Memory Bytes: History, Technology, and Digital Culture*, ed. Lauren Rabinovitz and Abraham Geil (Durham, NC: Duke University Press, 2004), and Brian Dolan, *Inventing Entertainment: The Player Piano and the Origins of an American Industry* (Lanham, MD: Rowman and Littlefield, 2008).
36. Kurt Vonnegut, *Player Piano* (New York: Scribner, 1952).
37. Steven Moore, "The Secret History of *Agapē Agape*" (2000), available at www.williamgaddis.org/critinterpersays/secrethistoryaa.shtml (accessed 1 February 2009).
38. Ed Park, "The Precognitions: On the Posthumous Trail of W. G. Sebald and William Gaddis," *Voice Literary Supplement*, Fall 2002, available at TheUnarchivable.blogspot.com/2007/09/piece-on-sebald-gaddis-and-bernhard.html (accessed 1 February 2009).
39. William Gaddis, *J R* (New York: Knopf, 1975).
40. Gaddis, *J R*, 288–89.
41. Oscar Wilde, "Impressions of America" (1883), reprinted in *The Annotated Oscar Wilde*, ed. H. Montgomery Hyde (New York: Clarkson Potter, 1982), quoted in *The Gaddis Annotations—J R*, www.williamgaddis.org/jr/jrnotes5.shtml (accessed 1 February 2009).
42. William Gaddis, *Agapē Agape* (New York: Viking, 2002).
43. Moore, "Secret History of *Agapē Agape*."
44. William Gaddis, "Agapē Agape: The Secret History of the Player Piano," in *The Rush for Second Place: Essays and Occasional Writings* (New York: Penguin, 2002), 13.
45. Weber also said nothing about phonographs, although he had used phonograph recordings extensively in preparing the work later published as *The Rational and Social Foundations of Music*. See Christoph Braun, "The 'Science of Reality' of Music History: On the Historical Background to Max Weber's Study of Music," in *Max Weber and the Culture of Anarchy* (New York: St. Martin's, 1999), 190.
46. Gaddis, *Agapē Agape*, 48.
47. H. H. Stuckenschmidt, "The Mechanization of Music" (1925), in *German Essays on Music*, ed. Jost Hermand and Michael Gilbert (New York: Continuum, 1994), 149–56. See also Alan Durant, *Conditions of Music* (London: Macmillan,

1984). On Glenn Gould, see, for example, Glenn Gould, “The Prospects of Recording,” in *The Glenn Gould Reader*, ed. Tim Page (New York: Knopf, 1984), 331–52.

48. See Kyle Gann, *The Music of Conlon Nancarrow* (Cambridge: Cambridge University Press, 1995); Eric Drott, “Conlon Nancarrow and the Technological Sublime,” *American Music* 22 (2004): 533–63.