

ROGER MOSELEY

Keys to play



Music as a Ludic Medium
from Apollo to Nintendo



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Roger Moseley



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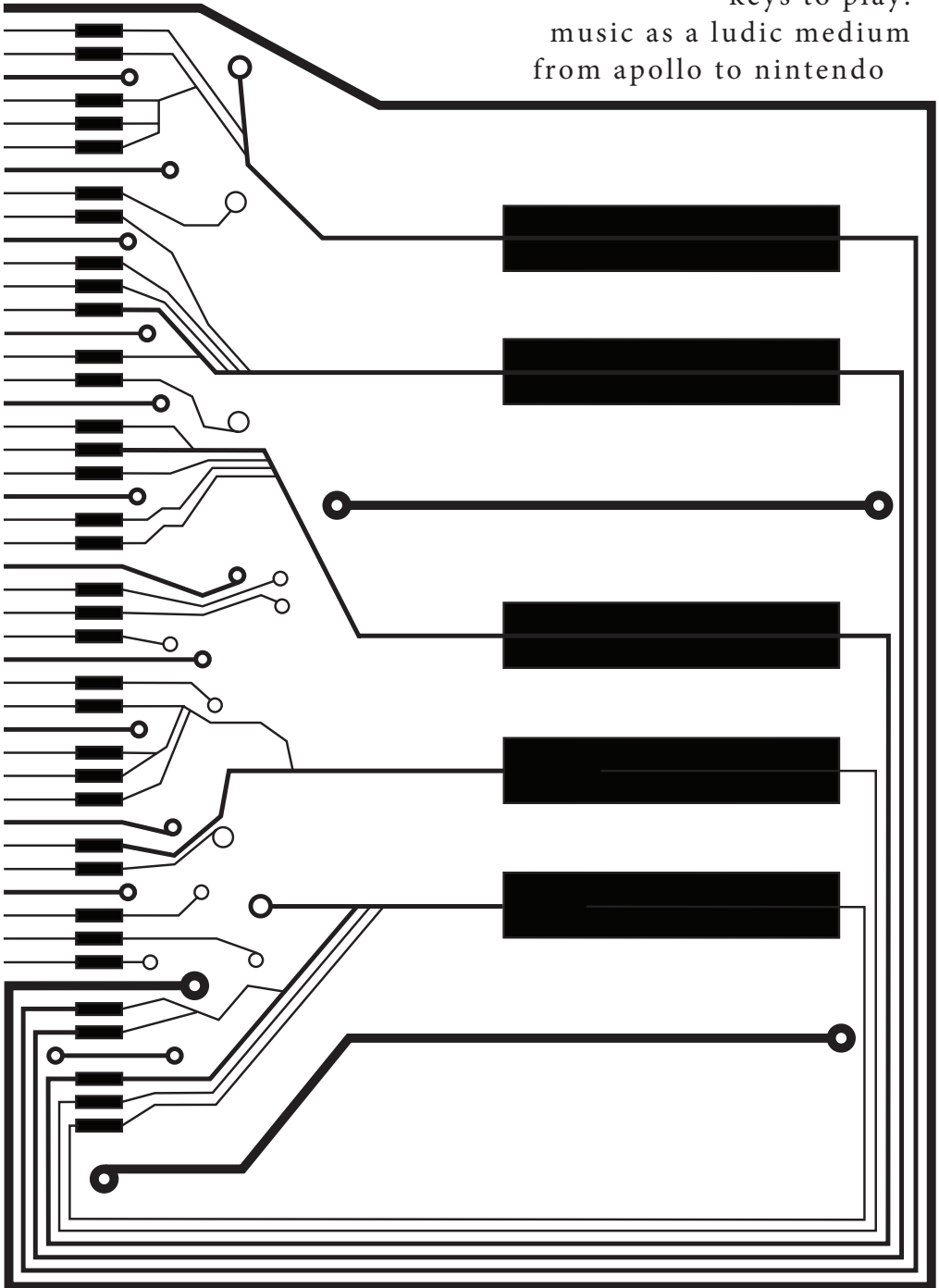
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*To my family, with love and gratitude,
and for Verity, my song of songs.*

keys to play:
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from apollo to nintendo



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As my digits near the end of this protracted tap dance over my computer keyboard, it is a pleasure to reflect on the choreographers, partners, and fellow players—new and old, close and distant, willing and oblivious—whom I am lucky enough to have encountered along the way. To start with the most recent, I am grateful to my editor Raina Polivka, her predecessor Mary Francis, project editor Francisco Reinking, eagle-eyed copyeditor Robert Demke, and editorial assistant Zuha Khan at the University of California Press for the faith they have shown in this project and their hard work in bringing it to fruition. I am particularly appreciative of the feedback from William Cheng, Emily Dolan, Alexander Rehding, Benjamin Walton, and the anonymous readers for the press: their thoughtful observations proved invaluable.

From the outset, UC Press encouraged me to explore the exciting possibilities offered by Luminos, its new open access publication program. Since this book deals with the materiality of mediation, it is fitting that its appearance on this platform has involved getting to grips with the affordances and constraints of multiple analog and digital formats, from the venerable PDF scroll and the random access of the print-on-demand tome to the ePub document's wherewithal for rich multimedia content. While it has presented challenges, devising a book about musical play containing elements that can be set in audible and visible motion has been a transformative experience, allowing me to realize ideas that would previously have been unimaginable. As an admirer of the vision on which Luminos has been founded as well as the expertise of Paige MacKay, her colleagues at Ubiquity Press, and the production team at diacriTech who have helped to realize it, I am delighted that this book appears under its imprimatur.

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vvv

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Prelude

Press Any Key to Start

Drawing on conceptual models informed by theories of play, media, systems, and cultural techniques, this book pursues the significance of play across a panorama of musical phenomena extending from Greek myth to contemporary digital games. In particular, it examines forms of play that have emerged at the digital interface of the keyboard. By situating the keyboard in a range of historical, cultural, and epistemological contexts, *Keys to Play* explores how it has been played in a multiplicity of ways (and to as many ends) by composers, improvisers, performers, and gamers. Reciprocally, the book makes the case that the keyboard itself has played the role of a medium, which is to say a means of generating, processing, relaying, storing, and accessing information. At the keyboard, play becomes apprehensible as a primary means by which musical behavior can be materialized, embodied, performed, and communicated. Through its affordance of modes of engagement that are at once playful and musical, the keyboard is implicated in diverse forms of what might be called *ludomusical* praxis.

As a threshold at which music becomes playable and play becomes musical, the keyboard defines a strand of ludomusicality that has woven its way across broad swathes of time and space. In mapping its course, the book shuttles back and forth to frame the keyboard from oblique historical, cultural, and disciplinary angles, some running parallel and others intersecting with established musicological perspectives. The warp and weft of this ludomusicological approach trace the criss-crossing processes by which music has been devised, realized, and recreated at the keyboard via techniques both in keeping and at odds with the prevailing rules of play.

Despite what Johan Huizinga identified as the “remarkable” etymological and historical connections that demonstrate the profound “affinity between music and play,” the substantial body of literature on play has made little impact on the study of Western art music.¹ In large part, the suppression of ludomusical discourses and practices in musicological scholarship reflects their virtual absence from the archival record. Accordingly, *Keys to Play* departs from the premise that the linear models of historical narrative typically assembled from the interpretation of textual evidence are unfit for the purpose of representing musical playfulness and its modes of mediation. Since ludomusical rules often defy the unidirectional logic of cause and effect, they demand alternative means of accounting for their principles of operation and cultural functions as well as for the conformity and resistance they have engendered. In order to register the keyboard’s distinctive role as a medium that has conveyed, reflected, and shaped the formation of these rules, the book delineates the varied implications and realizations of keyboard play not by way of a sweeping narrative arc, but via shifting configurations of digital and analog cultural techniques.

The word “digit” refers to both a finger and a number, and the keyboard has long constituted a field of play where these two meanings come together. As early modern descriptions of the keyboard as an “abacus” suggest, the digital is rooted in the embodied performance of calculation. Beyond that, the keyboard’s interface forms a digital medium in its configuration of discrete, commutable elements and its dependably arbitrary mapping of input onto output. In both musical and computational contexts, this enables it to represent letters as well as numbers and pitches, and thereby to mediate between literate script, algorithmic program, and sonic signal. Furthermore, as Wolfgang Scherer has observed, keyboard play has long involved the encoding and decoding of musical transmissions, tasks accomplished by way of sophisticated techniques acquired through intensive training.² As a means of measuring, ordering, equalizing, and articulating musical differences, most notably across the contiguously frequential realms of pitch and rhythm, the keyboard’s field of play enables digital actions to be quantified, evaluated, and compared according to formal and ideological codes of conduct, whether they have to do with compositional protocols, standards of performance, or improvisatory capacities.

Digital techniques and technologies can only go so far in accounting for the teeming variety of musically playful phenomena, however, for they are always supplemented by analogical counterparts. Analogical play relies on correspondences and oscillations, on one object or action echoing, tracing, or indexing another. Analogical relationships model the transduction of a musical phenomenon from symbol to signal and for the capricious leaps and freewheeling associations characteristic of play in its gestural and theatrical senses. The sweep of a harpsichordist’s arms over the plane of the keyboard and the phenomenon of

Bebung at the clavichord can be understood to operate analogically, exemplifying continuity of motion and triggering commensurate modes of signification and understanding. More broadly, the subjunctive mood (the “as if”) of fantasy and make-believe is analogical, whether figured as mimesis, mockery, simulation, or simulacrum.

In order to track formations of play that have traveled freely across digital and analog domains, *Keys to Play* construes ludomusical activity at the keyboard as—and by way of—a constellation of *digital analogies*. A digital analogy situates digital and analog phenomena relationally rather than drawing a binary distinction between the discrete and the continuous. On the one hand, this acknowledges the keyboard’s myriad forms and transformations; on the other, it recognizes that its defining digital attributes form a relatively stable point of reference over the course of centuries, enabling these different forms to be profitably analogized as sites of ludomusical encounter between bodies and machines. At the keyboard, digits operate as natural phenomena, as agents of cultural forces, and as the means of distinguishing between the two. Correspondingly, digital analogies register both the forces that have shaped forms of play at the keyboard and the strategies that have been held to account for them. Rather than fetishizing difference or insisting on identity, digital analogies uncover and demonstrate both the recursive nesting of technomusical configurations and the continuous modulation of ludic dynamics that have enabled one term, symbol, object, or being to stand for another.

Digital analogies are predicated on Huizinga’s conviction that play is elemental rather than epiphenomenal: playful activities “do not proceed from culture, [but] rather precede it.”³ As a cultural technique, moreover, musical play forms (and is formed by) sequential processes that link humans to objects in ways that simultaneously configure the rules of play while making them conceivable and writeable as such. In other words, ludomusical rules exist a priori insofar as they establish the conditions for play, but they also attest to the recursive processing of play as a set of symbolic functions. On the one hand, this helps explain the always-alreadiness of rules and the sense in which they are inherited as inviolable legacies; on the other, it clarifies their drastic contingency and their legibility or decipherability as evidence of social regimes. As illustrated by Gregory Bateson’s classic example of a playful nip that at once is and is not a bite, play simultaneously enacts and frames its own ontology: it constitutes territory, map, and the means of relating the two.⁴ When players play, they also play with play. In the terms of Niklas Luhmann’s systems theory, the (meta)communicative strategies of play illustrate how “recursive operative chains bring about a switch from first-order to second-order techniques (and back),” as Bernhard Siegert formulates it.⁵ For participants and observers alike, the paradoxical logic of play shuttles between the material and the symbolic as well as between the real and the imaginary, revealing the worlds it creates to coexist with those on which it reflects

The play of numbers, notes, fingers, and keys thus invites us to contemplate music and technology less as distinct categories and more in terms of how technologies can be understood as always already musical, and vice versa. From Mozart's keyboard music to Nintendo's games, the concept of the digital analogy can be brought to bear on a set of historically and culturally far-flung yet epistemologically adjacent sites where the digital manipulation of symbols and their analogical modulation into audible signals operate in concert. As well as establishing conditions under which ludomusical modes of behavior can emerge, a system of play can help describe the formation of relations between individuals via the cultural techniques it prompts them to acquire and perform.

In the first instance, accounting for ludomusical play requires a thorough description of the relevant symbols and materials (the software of musical scores and binary code, the hardware of instruments and computers) and procedures (logical, combinatorial, and algorithmic) that unfold in relation to its rules. Beyond that, social, political, institutional, and aesthetic dynamics transform materials into interfaces and procedures into techniques. Accordingly, *Keys to Play* brings documentary discourses of pedagogy, improvisation, and performance at the keyboard alongside embodied and material evidence in order not only to unscramble the written and unwritten codes of conduct regulating ludomusical activities, but also to reflect the interactive means by which they have been realized by subjects and objects. To this end, the book focuses less on scores and other texts that explicitly thematize musical play and more on the tacit rules and ludic dynamics from which challenge, illusion, and uncertainty have emerged in the course of instrumental music-making. In so doing, it explores how the material and epistemological conditions under which musical play plays out inform larger questions concerning agency, autonomy, embodiment, gender, sensation, presence, and meaning.

Reciprocity between the animate and the inanimate world, between intention and contingency, is central to play: as Hans-Georg Gadamer put it, "all playing is a being-played."⁶ It is in this chiasmic spirit that *Keys to Play* deploys music in order to shed new light on the history of ludic techniques and technologies while identifying long-standing elements of play that continue to animate musical culture. On the one hand, apprehending the means by which music has been played promises to expand our understanding of the material history and cultural significance of ludic phenomena. On the other, focusing on play promises to bring associated concepts, affects, and modes of behavior—competition, collaboration, simulation, strategy, dexterity, levity, risk, pleasure, desire, fantasy, and abandonment—to the attention of musicologists.

While *Keys to Play* addresses a wide array of ludomusical topics and case studies, many of them revolve around a temporal axis that connects the explosion of digital games over the last fifty years to the second half of the European eighteenth century. As Jessica Riskin observes, both eras staged "the emergence of artificial

life in a flurry of attempts to simulate with machinery the physiological processes and cognitive behaviors of living creatures.⁷ Drawing parallels between the epistemological upheaval wrought by the onset of the industrial and informational revolutions, Riskin suggests that while simulation sheds light on the capacities and shortcomings of the technological means available in any given epoch, it can also transform conceptions of the object or process being simulated.⁸ From this perspective, the musical automata fashioned by Jacques de Vaucanson (1737) and Pierre and Henri-Louis Jaquet-Droz (1774) bespeak not only eighteenth-century notions of musicality and its degrees of imitability, but also the technological principles shared by the automatization of timepieces and textile looms as well as the playing of musical instruments, all of which informed the twentieth-century development of digital computation.⁹ In turn, the digital game provides a model for conceiving of eighteenth-century music as a system that affords playful experiences both despite and owing to the formal and mathematical logic underpinning its operations and the social, cultural, and historical meanings attached to their outcomes.

Such parallels suggest both why the latter stages of the eighteenth and twentieth centuries were so receptive to multiple forms of play and how the primary driver behind many of the technologies that facilitated them was the relentless quest for military and economic advantage in the geopolitical game of thrones. The complexity of these relations demands an approach to ludomusical phenomena that recognizes their potential for bringing about inequity and violence as well as fair play and bonhomie. To that end, and in the terms promulgated by Michel Foucault, this book's method is archaeological and genealogical.¹⁰ It is archaeological to the extent that it is based on the discursive ordering of objects in ways that construct the technologies through which the functions of these objects become articulable. It is genealogical in that it registers the chronological continuities and ruptures disclosed by archaeological formations and reveals how the horizons of the imaginable have constantly shifted over time. Moreover, it is informed by the media-analytical techniques of Friedrich A. Kittler, particularly insofar as they represent the playing out of Foucault's principles in explicitly technological terms. Kittler's concept of the *Aufschreibesystem* (usually translated as "discourse network"), which maps out discursive operations that unfold according to epistemic "rules," supplements Foucault's archaeology, while his analysis of the origins, functions, and appropriations of media technologies across military, civic, and domestic domains elucidates the genealogical transformations of musical play.¹¹

To accommodate the manifold instantiations and qualities of ludomusicality, *Keys to Play* is constructed in a way that reflects its archaeological and genealogical concerns as well as its digital and analogical orientations. Simulating the interface whereof it speaks, the book is composed of five chapters mapped onto the black keys that fall within the span of an octave, forming a pentatonic collection that evokes the keyboards of Jean-Maurice-Émile Baudot's multiplexed telegraph

system (1874, Figure 8) and Konami's *beatmania* digital games (1997–2014, Figure 9) as well as Chopin's "oddly playful" Étude in G flat, op. 10, no. 5 (1830), known as the "Black Key."¹² Moreover, and as illustrated in the frontispiece, each Key is itself composed of a Prelude and five miniature Keys. There is a logic behind the sequential ordering of the five principal Keys, the ramifications of their twenty-five offshoots, and the explicitly recursive preoccupations and functions of the five Keys on both micro and macro levels. That notwithstanding, the relations between the book's Keys can be apprehended in parallel as well as serial terms: like the tones of the pentatonic scale, they can be activated in multiple melodious and harmonious configurations

The two-plus-three configuration of the black keys also articulates the book's broader division into two parts. The first two Keys form a dyad that introduces the concept of ludomusicality and the theoretical model of the digital analogy, conceiving of the keyboard as a field of play that covers extensive historical and cultural terrain. The latter three Keys each engage with a specific mode—improvisatory, performative, recreative—by which ludomusicality has been facilitated and regulated. Via case studies drawn largely from European keyboard music and Japanese digital games, these Keys investigate how the acts of generating, notating, performing, analyzing, and listening to music can illuminate aspects of play that have been occluded from other disciplinary perspectives.

All these forms of ludomusical behavior involve bodies, objects, and the interfaces that both mark their boundaries and bring them into contact. As an archetypal example of such interfaces, the keyboard is a field of play capable of staging fierce competition, tender collaboration, obedient execution, and unexpected resistance. The keyboard does not merely mediate between player and sound: as a musical platform, it also acts as a generator, processor, and transducer of notation, which can be understood as a script to be performed, as a log resulting from extemporization, or as code to be decrypted and transmitted (in which sense the term "key" is etymologically entangled with the concealment and unlocking of meaning). The various logics according to which the keyboard musically maps input and output constitute the rules that regulate its multifarious modes of ludomusical play.

The first Key explores the concept of ludomusicality and its manifestations in contexts ranging from the mythical contest between Apollo and Marsyas to contemporary digital games. Its approach to musical play navigates a course in relation to routes established by Plato, Kant, Schiller, Herder, Nietzsche, Huizinga, Roger Caillois, Gadamer, Foucault, Kittler, and contemporary scholars of ludic phenomena. Informed by Caillois's influential taxonomy, the Key assembles a theoretical framework that acknowledges the interactive dynamics of play, its rational and strategic elements, the psychoaffective states and behavior it can inculcate, and its balancing of the predetermined and the indeterminable.

Responding to recent maneuvers in the theory and archaeology of media, it also lays out a methodological template that accords players, objects, and techniques the explicatory wherewithal to shed light on earlier phenomena in ways that do not necessarily adhere to time-honored notions of sequence and causality. Via the rhetorical strategies of recursion, catachresis, skeuomorphism, and retronymy, digital games and the music they stimulate players to improvise, perform, and recreate provide a lexicon with which to recount playful musical phenomena from the past as well as the present. A consideration of Mozart's Sonata for Two Keyboards in D, K. 448/375a (1781), can inflect our understanding of cooperative multiplayer modes of digital gameplay; at the same time, the ludic practice of the "speedrun" might reframe the reception history of Chopin's "Minute" Waltz, op. 64, no. 1 (1847). In the posing and investigation of such relations, notions and terminology associated with digital games are capable of enlightening historical ludomusical praxis, just as the latter informs the former.

The second Key expounds the notion of the digital analogy and excavates the keyboard as a site where finger and number have long coalesced in the form of digital play. Embedded in instruments and devices as diverse as the clavichord, the typewriter, the nineteenth-century "logical piano," and the twenty-first century *Doom* piano, the topologies of keyboards provide media-archaeological evidence of how the material formations and functions of interfaces have both remained stable and changed over time as they have continuously guided and responded to human digits.¹³ At the same time, keyboard interfaces have conjured meanings and allusions that far exceed the immediate limits of their digital functions. Procedures at the keyboard have had important roles to play regarding musical composition, improvisation, and performance, but they are also related—both digitally and analogically—to processes of communication, industrialization, and computation, all of which have also been conspicuously entangled with the assignment and performance of gender. Tracing this lineage involves delving into the keyboard's murky origins by way of the chekker, a quasi-mythical fourteenth-century keyboard instrument associated with numerical calculation and the playing of chess. In charting this genealogy, the Key activates an array of texts including Kittler's analyses of media, Vilém Flusser's writings on technology, and recent scholarship on cultural techniques.

The ludomusical aspects of improvisation, performance, and recreation form the chief topics of Keys 3, 4, and 5, respectively, which focus on keyboard music devised by Mozart, Beethoven, and others alongside an analogous selection of digital games. As is the case with the trio of black keys onto which they are mapped, the adjacency of these Keys indexes serial, sequential, and iteratively looping relations. While they exist independently, the topics they address are as continuous as they are discrete: just as improvisation can shade into performance, so can performance be understood as a form of recreation that can in turn engender new forms

of improvisation. This flux is personified by the figure of Mozart, who looms large over these three Keys both as a matchless exponent of ludomusical maneuvers at the keyboard and as an avatar for the persistent remediation of musical play across generic, technological, geographical, and chronological borders.

Improvisation brings about the emergence of play (and vice versa) in ways that attend less to explicitly notated rules and more to the processing of the codes of conduct that program both the long-term acquisition of keyboard techniques and the social interactions performed in the course of real-time music-making. The performance of notated music can stage a ludomusical game after the manner of a scripted theatrical play. Finally, recreative play redistributes ludic agency among human and nonhuman “players” via techniques and technologies of encoding, decoding, and reenactment. In this form of play, the technological resources represented and materialized by musical scores are typically processed at a keyboard interface in order to be stored and recreated via digital hardware and media, such as the barrel organ, the player piano, or a Sony PlayStation 2 running *Guitar Hero* (2005).

From C. P. E. Bach to *Sid Meier’s C. P. U. Bach* (1994), the third Key explores the ludic dimensions of improvisatory musical devices—textual, algorithmic, and mechanical—played over the course of the last four centuries. The musical generativity of such devices can be traced back to the combinatorial epistemologies articulated by Ramon Llull, Athanasius Kircher, and Gottfried Wilhelm Leibniz. Such procedures were embedded in the pedagogy of compositional techniques; in addition to fulfilling utilitarian functions, however, combinatorial logic, aleatoric selection, and the (in)calculability of probability were responsible for ludic diversions in the form of the musical dice games devised by numerous musical figures after the fashion of Johann Philipp Kirnberger’s blueprint (1757). As methods of both cultivation and entertainment, such devices reflect the changing codification of uncertainty and its effects on the production of information. Pedagogical treatises, *partimenti*, dice games, and even normative musical scores operated as “paper machines” that called for the active participation of players and the collusion of chance as well as (or instead of) musical skill.

To the extent that they came into being via the process of being played rather than being read, all such texts can be construed as ludomusical programs. At the same time (and as the range of Mozart’s ludic activities vividly demonstrates), the emergence, development, and performance of extemporaneous techniques relied on the theatrical imbrication of textual, material, formal, and social elements, illustrated by the formulaic *canovacci* (plots) and *lazzi* (skits) of the *commedia dell’arte* as well as by highly refined compositional strategies. Musicians, actors, dancers, and masqueraders such as Mozart extemporized, modeled, and parodied various forms of sociality by staging the unforeseeability of dynamic processes that ricocheted against the boundaries of convention.

Insofar as improvisation was understood to emerge from the confluence of combinatorial logic and aleatoric dynamics, tensions arose between the ever-increasing technological sophistication with which these principles could be automated and the protocols associated with Romantic individuality, inspiration, and inimitable genius. In 1821, Diederich Nicolaus Winkel unveiled his “componium,” a mechanical organ endowed with extemporaneous powers by virtue of musical software (dual barrels pinned with interchangeable musical modules) and hardware (roulette-style wheels that quasi-randomly selected the next module to be played). The componium was a machine that could autonomously play music that had never been heard before and would, in all likelihood, never be repeated. In form and function, it anticipated *C. P. U. Bach*, software for the similarly ill-fated 3DO digital game console that algorithmically “improvises” music cast in the image of J. S. Bach’s. Digital games thus disclose not only how systems of play continue to be distributed across human and mechanical realms, but also why they have long served as loci of aesthetic and ethical debates concerning the vital and the material, the involuntary and the intentional, the emergent and the overdetermined.

In the traditional workflow of Western art music, scores tend to precede and prescribe performance, whether they are interpreted as a strict and comprehensive list of instructions or as looser scripts that stage musical events in a manner akin to theatrical plays.¹⁴ But to score is also to mark or to tally: in relation to musical improvisation or the playing of games, scores *follow from* performance. Placing scores in the context of codes that regulate and issue from digital gameplay of other kinds reveals how they not only define the rules according to which ludomusical experiences transpire, but can also be understood to quantify such experiences, both improvised and prescribed.

Centered on music by Mozart and Beethoven, the fourth Key addresses the multiple roles played by scores from the perspective of ludomusical performance at the keyboard, suggesting that they be construed less as a corpus of prescriptive texts than as sets of generative rules of play crystalized from the kinds of improvised events and experiences addressed in Key 3. Such scores choreograph ludic interactions between minds and mechanisms via digits and keys: they are not merely literary utterances, architectural plans, or theatrical scripts, but technologies that afford and constrain musical play. Correspondingly, analysis of the performances that issue from these scores might recognize the real-time ludic dynamics they engender as well as conventional relationships between notated symbols, embodied actions, and sonic outcomes.

To explore these ideas, the Key traces the ludomusical ramifications of phenomena encoded, triggered, and regulated by scores that involve keyboards in different capacities. In this light, it is telling that many of Mozart’s favored instrumental playmates—Josepha Auernhammer, Barbara Ployer, Regina Strinasacchi,

his cousin Maria Anna Thekla, and his sister Maria Anna (“Nannerl”)—were female, hinting at the gendered dynamics that shaped the performance of ludomusicality within and across disparate milieux. Play-by-play accounts of excerpts from Mozart’s Sonata for Keyboard and Violin in B flat, K. 454, the Sonata for Two Keyboards, and the Keyboard Concerto in F, K. 459, all of which the composer publicly performed in 1784, illustrate the competitive, collaborative, and virtuosic aspects of play put on display via digital and analogical operations. In particular, the dynamics of the keyboard concerto and the playful exploits of its protagonist are considered in light of the Harlequinesque attributes of Nintendo’s classic character Mario. Like Mozart, Mario’s celebrated designer Shigeru Miyamoto mapped out hazardous runs and leaps in order to provide players with ample opportunity to display their virtuosity and ingenuity. For Miyamoto as for Mozart, ludomusical performance has to do with theatrical and imaginative mechanics that resist explication in terms of formal principles and semantic operations alone.

Subjected to a two-pronged assault by the socioeconomic forces of utilitarianism and industrialization on the one hand and Hegelian aesthetics on the other, play found itself on the back foot for much of the nineteenth century. Right off the bat, the single-player games of Beethoven’s Piano Sonata in E flat, op. 31, no. 3 (1802), and the set of Bagatelles published as op. 33 (1803) point up ironies that can be linked to the composer’s encroaching deafness and its media-archaeological consequences, processed at and by the keyboard as a recreative as well as a generative and performative device. In Beethoven’s wake, the stature of play was trivialized and infantilized as musical elites—and, concomitantly, the nascent discipline of historical musicology—clustered around the notion of work as both ethos and unit of cultural production. Yet, as Dana Gooley, David Trippett, and Melina Esse have shown with regard to the ludomusical phenomena of virtuosity and improvisation, the nineteenth-century decline of play as everyday musical praxis was often coeval with its elevation as discursive ideal.¹⁵ Bearing witness to this process, Georges Bizet’s *Jeux d’enfants* (1871) reveals how play at the keyboard became intimately bound up with the sensual and affective operations of memory. Bizet’s twelve miniaturized evocations of children’s toys and games are imbued with nostalgia for the innocence of bygone days. By mounting a four-handed display of remembering and recreating, the performance of *Jeux d’enfants* indicates how playing back the past at the keyboard might be construed as *replay*, a means of reconstructing the temporality of musical events that supplements the history of recording as most commonly recounted.

From barrel organs and music boxes to *beatmania* and *Guitar Hero*, the digital mechanisms and programs implicated in these modes of recreation have themselves been criticized as monotonously jejune and thus symptomatic of phylogenetic immaturity, reflecting the disparagement of play as a childish waste of time and other valuable resources. Such derogation also exposes the imposition

of phonographic criteria of “fidelity” and “naturalness” on ludomusical phenomena, setting Romantic standards of which they inevitably fall short. In this light, recreation constitutes an alternative to the nineteenth-century obsession with (proto-)phonographic inscription and reproduction founded on acoustic traces that could be made to speak for themselves. Whether realized automatically or via direct human involvement, recreation does not transduce prescribed sonic waveforms in the manner of the phonograph, but rather draws on the combined forces of multiple symbols and operators—bits, notes, pegs, keys, buttons, fingers, and hammers—to put music (back) into play. If reproduction analogically traces stored sound as cursive inscription, in other words, recreation processes it as digital code. This code is not merely read, deciphered, and interpreted, but *run*: it entails the active navigation of a topography that can be (re)presented as a ludomusical landscape, whether mapped out as a pattern studding an organ barrel, as a course of action for digits to perform at a keyboard, or as a parade of challenges to be met via the dexterous playing of *Super Mario Bros.* (1985)¹⁶

Unlike the trekking of the stylus through the valley of the phonographic groove, the passage of such processes is not necessarily predetermined and linear, but involves the commutative calculation of steps, leaps, loops, and spirals that arise from the recursive nesting of performative commands. Digital code does what it says.¹⁷ It thus exemplifies first- and second-order modes of engaging with musical texts that complement the phonographic emphasis on the reanimation of archival sources via a faithfully literal “reading” of the evidence. While still firmly grounded in historical milieux, recreative methods of inquiry hold the promise of showing as well as telling how ludomusical phenomena emerge via the mechanics of play. Although the keyboard is not a requisite component of recreative systems, its digital principles and mechanisms provide the most obvious point of access when it comes to identifying the sites, means, and motives of ludomusical replay, which calls on players both to observe and to participate.¹⁸

As can be inferred from its illustration in the frontispiece, which incorporates iconographical elements from Conrad of Zabern’s fifteenth-century keyed monochord (Figure 16) and *C. P. U. Bach* (Figure 47 and Video 5), the fifth and final Key recursively plays back themes addressed throughout the rest of the book. It does so in the immediate context of contemporary ludomusical environments, which Nintendo’s digital games exemplify and mediate. This recreative paradigm is outlined against the backdrop of ludomusicality as defined in Key 1 before Nintendo’s ludomusical instruments trigger a recapitulation of Key 2’s exposition of the digital analogy from a complementary media-genealogical angle. Gameplay as improvisatory praxis is subsequently examined along the lines drawn in Key 3, focusing on games, toys, and *objets d’art* devised by media artist Toshio Iwai that thematize the ludic emergence of music from generative processes of various kinds. Finally, scores and the performance of digital gameplay as discussed in

Key 4 are reprocessed in light of the remediation of “classical” keyboard music via *Nodame Cantabile: Dream Orchestra* (2007), a game for Nintendo’s Wii console based on a popular *manga* by Tomoko Ninomiya set in the fictional Momogaoka College of Music.¹⁹ *Nodame Cantabile* is both a symptom and a diagnosis of the game-theoretical conditions that regulate the pedagogy and evaluation of “classical” music within institutional contexts: by quantifying and measuring players’ performances, it channels and distorts ludomusical factors associated with the “high scores” that compose the Western musical canon. Despite their ostensibly toylike superficiality and ephemerality, the mechanics of such games rely on epistemological formations that can be tracked through cultural and musical history. In turn, digital games can illuminate these historical manifestations of ludomusicality, suggesting alternative methods of construing chronological relations that recognize the ludic forces of improvisation and performance as well as the textual and material formations that have enabled and constrained the transmission of music.

“All playing is a being-played”: the chiastic and fractal logic of this final Key’s recursive maneuvers reframes the capacity of play to invert relations between subjects, objects, and musical modes.²⁰ Playing back the concept of playback, *Keys to Play* concludes by revisiting the topography mapped out in the course of its unfolding, inviting the reader to keep exploring the permutations afforded by its pentatonic modes and to return to the keyboard’s field of play with a renewed awareness of the ludomusical dimensions it can unlock.

Part I

Fields and Interfaces of Musical Play

*How oft, when thou, my music, music play'st
Upon that blessed wood whose motion sounds
With thy sweet fingers, when thou gently sway'st
The wiry concord that mine ear confounds. .*

—Shakespeare, Sonnet no. 128, lines 1–4



Ludomusicality

How is music played? Responses will vary depending on where the stress falls in the question. “*How* is music played?” interrogates the agencies and mechanisms responsible for music’s coming into audible being. It asks how “play” can operate as a verb flexible yet precise enough to describe the striking of a drum, the agitation of a string, the vibration of a column of air, the depression of a key, and the tapping of an onscreen triangle: in other words, it inquires into the means of music’s embodied and instrumental mediation. Asking “How is *music* played?” shifts the emphasis to the ludic dynamics that can motivate the bringing forth of music and the senses in which the processes of improvisation, performance, and recreation are comprehensible as ludic modes of behavior.¹ Finally, “How is music *played*?” asks how music might be akin to other things one plays, such as solitaire, chess, rugby, roulette, *Tetris*, the fool, footsie, or truant.² In these senses, the playing of music can be related to the playing of games, to role-play, simulation, and deception, to calculation and strategy, to risk and uncertainty, to sociality and flirtation, even to the wanton—sometimes violent—pursuit of euphoria and self-abandonment. The elucidation of these relations is this book’s *raison d’être*.

Prompted by the sound and sight of the mysterious Dark Lady at the keyboard, the Shakespeare sonnet from which the epigraph for Part I is drawn revolves around the axis of play as topic and mode. Music issues from the motion of the Dark Lady’s “sweet fingers” while standing as a metaphor for the beloved herself: music at once plays and is played by music. At the material interface of the virginals (“that blessed wood”), her digital maneuvers are transduced into vibrations that delight the poet’s ear, leaving him tantalized and disoriented. The whimsy of Shakespeare’s textual play derives from the play of fingers and keys, the oscillation

of strings and sonic waves; the to-and-fro of repetitive motion carries an erotic charge that throws distinctions between subject and object, cause and effect, into pleasurable disarray. Framing music and play together in this way suggests that musical activities can realize playful concepts and, conversely, that play can be conceived in terms of musical engagement. Musical play and playful music take shape in the spaces that open up between sign and sound, instruction and execution, the probable and the implausible, the permissible and the imaginable.

Play's resistance to definition is one of its defining qualities. Typically negotiating between subject and object, the verb "to play" connotes a relational mode at the same time as denoting a particular type of ludic action. Even when "the play's the thing," which is to say masquerading as a noun, play never stops playing. Correspondingly, music is not merely the outcome of a certain type of play, but constitutes a set of cognitive, technological, and social resources for playing in and with the world through the medium of sound, its mechanisms, and its representations.³ Play, in turn, becomes the means by which such musical behavior is made audible. In these multiple senses, play activates music via patterns of actions that can be identified as *ludomusical*. Within (and against) the constraints that regulate it, ludomusical play fluctuates between the preordained and the unforeseeable, emerging in relation both to the performance of familiar cultural scripts and to the imperative to improvise.

Although play is often cited as an intrinsic attribute of humankind, it has long been observed that play is not exclusive to people, or even to gamboling animals.⁴ Play can also describe mechanical processes that animate inorganic matter by accident or design: we speak of the play of light, the play of a loosely fitting drawer, and the playing of chess by machines such as IBM's Deep Blue. Navigating the shifting material and cultural formations that regulate any given mode of musical play thus involves the traversal of both human and nonhuman realms. In Shakespeare's sonnet, the reciprocal relations of musical subjects and objects pivot around play, bearing out Gadamer's claim that "all playing is a being-played."⁵ Cornelia Vismann reframed this chiasmus in the discursive terms of media theory:

If media theory were, or had, a grammar, [the] agency [of media and things] would find its expression in objects claiming the grammatical subject position and cultural techniques standing in for verbs. Grammatical persons (and human beings alike) would then assume the place assigned for objects in a given sentence.⁶

As the Dark Lady and her virginals bear witness, such chiasmic encounters have often played out at the interface of the keyboard, where human meets mechanism and operation becomes technique. From the fourteenth-century chekker to contemporary digital games, the keyboard has formed a field of play on which musical epistemologies have been allegorized, tested, and challenged via the cybernetic configuration of input and output.⁷ While keyboards invite us to play music, the

automatism with which well-drilled fingers navigate them has been repeatedly invoked to illustrate how music can “play” us.⁸ Keyboards even help account for how music can play on its own: the player piano testifies to the possibility of musical recreation without anthropic contact.

When activated by human digits, however, the keyboard’s mechanisms become entangled in play as embodied and social experience. As Huizinga pointed out in his classic book *Homo Ludens*, the association between play and instrumental skill is most directly embodied by “the nimble and orderly movement of the fingers.”⁹ While such motion requires effort, it need not involve toil or strain: Sigmund Freud famously conjectured that the infantile origins of the delight taken in play’s to-and-fro oscillations have less to do with the arduous accomplishment of a particular task than with the pleasure taken in shaping, ordering, and repeating bodily movements that convert anxiety into security.¹⁰ Across many Indo-European languages, moreover, the roots of “game” and “play” are etymologically associated with movements that give rise to communal joy as well as personal pleasure.¹¹ The gestural qualities of such motions also reflect the social connections between playing, dancing, and miming observed by both Theodor W. Adorno and Gadamer in the context of the word *Spiel*.¹² Insofar as it reiterates such motions, even solo play responds to the play of other bodies.

As is most evident in its theatrical sense, play is also bound up with make-believe, the exercising of the imagination, and the fantastical possibilities afforded by the subjunctive mood. The phenomenological characteristics of play have less to do with intention and emotion than with entrainment and affect.¹³ Even without consciously simulating or dissimulating, one plays “as if,” thereby forging the connections between musical performance and role-play noted by Nicholas Cook.¹⁴ As a performative mode, play preempts and subverts questions predicated on linguistic concerns with communication, meaning, truth, and sincerity.¹⁵ More enactive than representational, play insists on the reality of pretense, allows for the simultaneous acceptance and circumvention of constraints, and thrives on the inevitability of uncertainty.

Since musical play often involves the abandonment of the self, or at least the temporary occlusion of its ulterior motives, it maintains a close relationship with ritual.¹⁶ As objects of play, both music and games are part of quotidian life, and yet they tend to take place in realms where everyday protocols are suspended. Whereas Huizinga went so far as to claim there to be “no formal difference between play and ritual,” however, Claude Lévi-Strauss placed the two in reciprocal relation: while rites transform events into structures, play transforms structures into events.¹⁷ This function of play is most apparent in ludomusical practices that, like sporting occasions, shift focus from the prevailing rules (often articulated and enforced by social conventions and incarnated by a particular body of repertoire) to the playing out of singular, unrepeatable events that emerge from

a particular ludic environment and its affordances. In the performance of much folk music, for instance, sonic and affective experiences are informed not only by the selection and transmission of musical materials, but also by factors such as the moods of musicians and audience, the tuning of instruments, and even the weather. Conversely, the traditional circumstances of Western art music in performance are closer to ritual insofar as the contingency of the individual event is typically downplayed in favor of a quasi-atemporal presentation of (more or less) fixed musical material. The ritualistic qualities of such performances are intensified by their circumstances: the hushed, darkened hall and the spatial separation of performers from spectators amplify the tacit signals governing the voluntary yet constrained actions taken by participants. Under these conditions, play is regulated by one of its antipodes, the musical work; as a result, particular concordances with and departures from the “rules” of the score are magnified and invested with interpretive significance¹⁸

To a greater or lesser extent, however, regulatory functions are to be found in all forms of presentational and participatory musical praxis, no matter how differently their parameters might be defined.¹⁹ In the jazz club as in the opera house, the fascination of ludomusical play lies in its shuttling between structure and event, the criteria established by formal and social models on the one hand and the *qualia* of an individual experience on the other. Accordingly, Huizinga noted that certain social sites, from the tennis court to the concert hall and the sumo ring to the court of law, are reserved for the staging of encounters and exchanges enacted according to particular rules. Such “magic circles” form ritual frames wherein the internal coherence of rule-bound systems is temporarily granted primacy over—or protection from—external exigencies.²⁰

Huizinga’s concept of the magic circle has recently come under fire, particularly from sociological angles. Critics bent on demystification have pointed out that all attempts to transcend the social are themselves symptomatic of social forces at work, and have thus dismissed the magic circle as an invidious formalist delusion.²¹ As Edward Castronova observes, magic circles are always materially and historically grounded, and the political processes by which they assert territorial integrity are subject to interrogation and negotiation: their membranes are permeable and the spells they cast can be broken.²² Even as they circumscribe play-spaces, the boundaries of magic circles connect them to the world outside; concomitantly, as Clifford Geertz noted, play takes place both within such circles and through their relations to what lies beyond.²³ Nonetheless, taking the illusory aspects of magic circles seriously can help us grasp the subjunctive, metacommunicative, and even paradoxical logic by which systems of play can frame arbitrary objects and contingent events as absolute and necessary. With the creation of a magic circle, a line is drawn that simultaneously marks and makes a difference in the world. To frame this in the recursive terms of Luhmann’s systems theory,

games are played in accordance with a digital logic based on epistemological distinctions (such as inside/outside or fair/foul) that make games themselves conceivable in relation to all that is not a game.²⁴ At the same time, as Jesper Juul puts it, “a game must be integrated into a context in order to be experienced as separate from that context.”²⁵ Oscillating between participation and observation, this double function can help clarify the specific topology of any given magic circle, where it is grounded, how and why it is drawn, and the genealogical shifts that its changing forms chart over time as particular elements of play are successively incorporated, privileged, marginalized, or excluded from social and historical configurations

Schiller observed that play constructs relationships between material and formal impulses so that “the operation of the one simultaneously confirm and limits the operation of the other.”²⁶ Negotiations between internal, quasi-autonomous rules and external forces account both for the courses taken by play—the unforeseeable and yet strangely inevitable way that things “play out”—and for its compelling appeal as event and spectacle. Those who play (with) music can transgress and subvert as well as obey the protocols that constitute the unwritten rules of engagement, and such play can on occasion transform the rules themselves.²⁷ As exhibited within and by artistic movements such as Fluxus, Situationist International, and OuLiPo, many of whose members were devotees of the surrealist parlor game known as *cadavre exquis*, play has often realized the tactical potential to mock, shock, and critique, whether by ignoring rules, observing them in the breach, or breaching them via absurdly literal observation.²⁸ From Dada to digital games, instances of transformative play reveal how subversion can either be integral to gameplay dynamics or emerge through imaginative counterplay with (and against) the rules that shape them. In itself, neither the following nor the flouting of rules is necessarily aligned with a particular aesthetic or political stance: the transgression of conformity often involves conforming to transgressive norms, and the representational implications of a game’s range of possible actions must be considered in relation to its underlying formal and mechanical principles.²⁹

In this regard, it is telling that both Schiller’s and Gadamer’s perspectives on play were indebted to Immanuel Kant’s *Critique of the Power of Judgement*, in which the free play of the imagination is identified as the animating principle behind intellectual pleasure.³⁰ For Kant, such pleasure derived from the law-bound exercising of freedom. Crucially, however, these laws are not necessarily either specific or universal, but rather issue from a sense of lawfulness that can itself be created by the imagination.³¹ This aligns with Kant’s distinction between the purposeful and the purposive: to the extent that they are legislated in the name of pleasure, the laws of play are arbitrary and lack moral purpose, rendering any beauty that results ultimately inconsequential, no matter how delightful it might be.³²

Herder condemned what he saw as the meaningless frivolity of Kant's formulation and drew on musical analogies in the course of rebutting it. For Herder, art had to do not with the playing of "amusing or tedious ape-like games," but rather with the perception of "good order and good form" via resonances between mind and world in accordance with the principles of natural law that regulate the harmonious relations of bodies and sensations.³³ Herder's claims were echoed by Georg Wilhelm Friedrich Hegel, for whom art was concerned not with "child's play, but . . . with an unfolding of the truth."³⁴ Combining Kant's receptivity to the aesthetic qualities of play with a Herderian concern for ontology and ethics, however, Schiller argued in his *Letters on the Aesthetic Education of Man* that the *Spieltrieb* ("play drive") had to do with far more than the childish pursuit of diversionary pleasure. Through interplay between life and form, power and law, nature and reason, "the freest and most sublime state of being" could be attained: "Man plays only when he is in the full sense of the word a man, and *he is only wholly Man when he is playing*."³⁵ In his "Conversation on Poetry," Friedrich Schlegel went even further, holding the play principle to account not merely for aesthetic beauty, but for the very formations of the universe, at once autopoietic and autotelic: "All the sacred games of art are merely distant imitations of the endless play of the world, the eternally self-creating work of art."³⁶

Although the immediate occasion of Schiller's *Letters* was his disillusionment with the French Revolution, his own faith in the profound power of play was drawn from Plato's *Laws*, in which the Athenian stranger decrees that men and women "should live out [their] lives playing at certain pastimes—sacrificing, singing, dancing—so as to be able to win [the gods'] favor."³⁷ In this sense, Schiller echoed Marsilio Ficino's praise of the oxymoronic capacity, shared by Plato, Socrates, and Pythagoras, for "joking seriously and playing assiduously [*iocari serio et studiosissime ludere*]."³⁸ As well as projecting his vision of a neo-Hellenic play-space to be realized via the cultivation of *Bildung*, Schiller's formulation of the *Spieltrieb* reflects the close relationship between the Greek terms for play (παῖδιá, *paidia*) and pedagogy (παιδεία, *paideia*) as well as their common root in παῖς (*pais*, "child"). As educational method and outcome, play can afford a childlike clarity of vision into the workings of the world as well as childish diversions from serious matters, a paradox encapsulated by Heraclitus's gnomic dictum: "Lifetime is a child at play, moving pieces in a game. Kingship belongs to the child."³⁹

Yet Schiller's invocation of what he imagined to be the ancient Greeks' pure delight in the edifying beauty of physical contests and intellectual rivalry reveals how tightly the phylogeny and ontogeny of play are bound together.⁴⁰ As memories of childhood attest, play was purer in the past, while its concrete manifestations in the present are always less than ideal. For Sven Lütticken, Schiller's paean to Greek play "introduced the *topos* of the fundamental inadequacy of

actual games, of their betrayal of the idea of play.”⁴¹ Schiller’s nostalgia for ancient Greece, his dissatisfaction with the present, and his vision of a better world to come were both inspired and tempered by his horror at the gulf that separated revolutionary ideals from the violent acts that made them matter. His ostensible rejection of Kantian dualism notwithstanding, Schiller maintained a crucial distinction between physical, animalistic play and the type of high-minded aesthetic play that formed both the apogee and the repudiation of human striving, for the former was too readily associated with the bloodlust of the Roman *ludi* or the Jacobin mob. As Mechthild Nagel observes, the material was synonymous with the abject for Schiller, who railed against the “mechanical artists” of the French Revolution in terms redolent of Herder.⁴²

Despite Schiller’s idealizing desire for play to transcend its mechanical basis, however, his acknowledgment of the relations between its material and its formal aspects echoed Kant’s claim that “in all liberal arts there is nevertheless required something compulsory, or, as it is called, a mechanism, without which the spirit, which must be free in the art and which alone animates the work, would have no body at all and would entirely evaporate.”⁴³ In this light, the changing relation between the shifting valorization of play and instrumental music in eighteenth-century German thought is revealing, as Peter Pesic and Felix F. Diergarten have noted.⁴⁴ The mechanical constraints of musical instruments enabled free play that was not subject to rational, emotive, or mimetic decoding (as was held to be the case for the sense and sound of vocal music). After being roundly disparaged by Johann Georg Sulzer, instrumental music’s semantic coyness was deemed praiseworthy by Christian Gottfried Körner and Christian Friedrich Michaelis, for whom instrumental music granted “the imagination [*der Fantasie*] lighter and freer playfulness . . . than when it is fixated on definite thoughts.”⁴⁵ In a similar vein, Ludwig Tieck remarked that instrumental music “fantasizes playfully.”⁴⁶ Read in the contexts of contemporaneous musical genres and their associated behavioral codes, these comments invoke the tendency of the late-eighteenth-century fantasia and capriccio to call upon—yet ultimately to elude—a sense of quasi-semantic logic by way of rapid affective feints and textural oscillations.⁴⁷ Such “free play” enabled hand and mind to join forces in enacting an organic process of discovery and creation. By 1826, Hans Georg Nägeli could confidently assert that music’s very “essence is play, through and through,” and that “the more . . . playful a musical composition is . . . , the more successful it is.”⁴⁸

While musical freedom from semantic strictures took the form of imaginative invention, such lofty play was typically articulated and materialized at the digital interface of the keyboard. Analogously, the free motion by which sound itself became audible was mechanically limited in order for it to be parsed as distinct pitches and rhythms, whether produced by the vibration of a string, the excitation of a column of air, or the play of the keys that could initiate either. Instruments and

the conceptual possibilities afforded and foreclosed by tonal systems combined to form epistemological structures that also outlined ludomusical fields of play. Such play takes shape as a realization of the potential for unpredictable interaction between players and objects and the constraints that regulate their motion: freedom on the one hand, limits on the other. From this perspective, the keyboard emerges as a digital means of articulating the distinctions by which play is defined and between which it oscillates.

How might we begin to identify the laws—explicit and tacit, material and conceptual—observed and breached in the course of ludomusical play? According to the principles of cultural techniques, a philosophical and anthropological assemblage of concepts and critical tools with which Vismann was associated, the answers should precede rather than follow linguistic models.⁴⁹ In other words—or perhaps with no words at all—we should take seriously Huizinga’s contention that play is constitutive rather than illustrative of knowledge, and that this knowledge is typically produced at interfaces between limbs and objects.⁵⁰ If, as Thomas Macho supposes, humans counted before the invention of numbers and singing came before the scale, then musical play surely preceded the devising of instruments and the tallying of scores.⁵¹ Once those technologies had been developed, however, ontological formations and ontographic operations combined to enable music and games to be played in accordance with rules—understood here as arbitrarily binding directives that both prescribe and proscribe—for entering into material and imaginary relationships with the world.

Before analyzing musical play and the ends to which it has been put, then, we should acknowledge the ways in which its chiasmic configurations supplement the oral, literary, and numerical methods by which subjects have been formed and cultivated. *Music and the techniques that shape it simultaneously trace and are traced by the materials, technologies, and metaphors of play.*⁵² It is in this sense that play does not represent so much as it simulates: rather than enacting “a passive, interior mimesis” of other phenomena, as Roland Barthes put it, the play of musical bodies and objects is emergent, procedural, generative, and recursive.⁵³ It has to do not with the production of meaning, but with the distinctions and oscillations on which meaning is predicated and by which it is processed.

This helps account for the cognitive and linguistic dissonance between the registers of musical discourse most explicitly associated with theory, praxis, and history. In their own ways, all three idioms are as remote from play as it unfolds in the here and now as they are from those who bore witness to the play of the past. How, then, might we speak of ludomusicality in a way that reflects both its currency and its historicity, its immediacy and its mediation? This Key attempts to unlock answers from five perspectives. By way of musical examples both mythical and historical, the first presents Caillois’s taxonomy of play as a means of recognizing its various forms and their associated characteristics. The second

considers play's antonymic relationship with work in the context of a nineteenth-century ontological and aesthetic agenda that continues to exert a strong influence over today's musical cultures. Since the proceedings of play have so often gone unrati- fied by the archival record, it has largely eluded the discursive grasp of historiography. The Foucauldian concepts of archaeology and genealogy suggest alternative ways in which play itself might constitute an epistemological mode capable of registering the spatial and temporal dimensions of musical phenomena. Accordingly, this Key's third component introduces the digital game as a contemporary manifestation of play that is historically and technologically implicated in audiovisual representations of conflict, while the fourth traces a media-genealogical lineage connecting seventeenth-century hydromechanical organs, eighteenth-century musical automata, nineteenth-century telegraphic interfaces, and late twentieth-century "rhythm-action" games. Finally, the fifth focuses on the haunting figure of Frédéric Chopin in order to tease out ways in which digital gameplay at the keyboard can obtrude from the passage of historical time, invoking and betraying the past in order to offer visions, at once utopian and dystopian, of how the future might play out.

1-1 ORDERS OF PLAY

Let us begin where Schlegel's "Conversation on Poetry" ends, accepting its invitation to loop back to what might be deemed a ludomusical origin myth: the fateful contest between the Greek god Apollo and the satyr Marsyas.⁵⁴ The myth's ludic drama and lurid violence have long fascinated artists and scholars, particularly those concerned with the establishment of hierarchical relations within and between artistic realms. In recent years, it has attracted the attention of Daniel Albright, John T. Hamilton, Lydia Goehr, Richard Leppert, Andreas Dorschel, and James R. Currie.⁵⁵ As is made evident in Key 2-1, the reading of the myth presented here is willfully anachronistic insofar as it brings out themes that resurface at unexpected historical junctures, foreshadowing or echoing techno-epistemological shifts that reach far beyond the ancient world⁵⁶

The basic outline of the myth is well established, although significant details vary among its sources.⁵⁷ Marsyas, a satyr from Phrygia, picked up an aulos discarded by Athena, who had been disgusted by its distortion of her facial features when she played it. Having been inspired by the breath of a goddess, the instrument produced beautiful music as soon as Marsyas blew into it, which delighted and emboldened him. The satyr rashly challenged Apollo to a musical contest to be judged by the Muses: the winner, it was agreed, could do whatever he pleased with the loser. Apollo played the kithara while Marsyas played the aulos (or perhaps two auloi at once).⁵⁸ After the first round, Marsyas seems to have held the advantage, forcing Apollo to resort to dubious tactics.⁵⁹ In one version of the myth

he added his voice to his kithara, while in another he played his kithara upside down, feats he knew Marsyas would be unable to match.⁶⁰ The Muses thus ruled in Apollo's favor; as punishment, Apollo had Marsyas bound to a tree and flayed alive. According to Ovid, his blood mixed with the tears of the satyrs and nymphs who mourned him to form a river that took his name, while others reported that Apollo repurposed the satyr's hide as an *askos*, a flask or pouch that could serve as wineskin, windbag, or drum.⁶¹

At first sight, this myth is hardly playful; on the contrary, it teaches a stern object lesson on the dangers of hubris and the provocation of divine wrath. The neo-Pythagorean music theorist Aristides Quintilianus was among many who rebuked Marsyas for "dignif[ying] his music beyond its worth."⁶² Contemporary readings of the myth thus have no trouble in identifying or extrapolating the illiberal forces that predetermined the contest's outcome.⁶³ The field of play was certainly tilted heavily in Apollo's favor: exoticized, feminized, and stigmatized by his choice of instrument even before he dared challenge a god, Marsyas was a marked satyr.⁶⁴ Just as the aulos had deformed Athena's features, so Apollo ensured that it led to Marsyas's excoriation.⁶⁵ The officious savagery of the punishment continues to elicit horror and sympathy, as it presumably did from the Roman courtesans who adorned the statue of Marsyas in the forum with flowers⁶⁶

It is nonetheless important to acknowledge that Apollo and Marsyas engaged each other in a form of play. Throughout the ancient world, play was often as brutal as it was divine: from the *παγκράτιον* (*pankration*, a mixed-martial-arts staple of the Olympic Games that could bring death as well as glory) to the Roman *ludi* (which incorporated athletic events, chariot racing, and gladiatorial combat into votive offerings and funerary rituals), games could have consequences wholly disproportionate to their nominal stakes, especially when staged as public spectacles.⁶⁷ In this light, it is telling that the Pythian and Isthmian Games featured kithara and aulos competitions alongside displays of athletic and martial prowess.⁶⁸

The Greek term *ἀγών* (*agōn*) captures the notion of competitive struggle in terms of both its ludic structure and the physical toll it can exact.⁶⁹ Although *agōn* was initially used simply to denote public ludic events from races to musical contests, the word "agony" became synonymous with the writhing contortions of bodies—like Marsyas's—that suffered the harrowing effects of play.⁷⁰ Huizinga perceived the principle of *agōn*, which he construed as the exhibition of prowess in specially demarcated locations under rule-based competitive conditions, to lie at the heart of culture *sub specie ludis*: "play is battle and battle is play."⁷¹ Huizinga also remarked on how the display of skill, the testing of one's own and others' limits while vying for victory, and sometimes even the endangerment of safety and well-being for no rational reason pervade many societies, often to an extent that defies all attempts at utilitarian explanation. The central thesis of *Homo Ludens*

holds that a culture's most vital elements should be understood as fundamentally playful to the extent that they involve challenge, competition, theatricality, virtuosity, and improvisation. For Huizinga, play in the simultaneously primal and rarefied form of *agōn* was responsible for the flourishing of cultural practices, networks, and institutions from dialogical philosophizing to the adversarial legal system, professional sports to the theater, and love-making to music-making. (This ludic perspective on the *theatrum mundi* was shared by Johann Mattheson, Handel's friend and dueling partner, for whom life's most intense and meaningful experiences "always had something playful" about them.)⁷²

The enduring importance of *agōn* to the staging of musical drama can be tracked across musical history. Goehr links the mythical clash of Apollo and Marsyas not merely to the god's analogous contest with his satyr-like counterpart Pan, illustrated in Figure 12 and recreated in J. S. Bach's cantata *Der Streit zwischen Phoebus und Pan*, BWV 201, but also to the bitter contest at the heart of Wagner's *Die Meistersinger von Nürnberg*.⁷³ Heinrich W. Schwab suggests that this lineage might be traced back to *Robin et Marion*, a thirteenth-century pastoral attributed to Adam de la Halle in which a shepherd and a knight vie for Marion's affections via reports of sporting activities—a game of football and a tournament—that map onto their disparate social ranks.⁷⁴ Gioachino Rossini's *La regata veneziana*, a set of three whimsical canzonettas in Venetian dialect, also entwines *agōn* and *eros*: over the piano's figuration, alternately lilting and intensely kinetic, the feisty Anzoleta coquettishly spells out the stakes of a gondola race to her would-be beau Momolo, offers breathless commentary on the event itself, and subsequently rejoices in Momolo's victory.⁷⁵

Numerous other musical productions have taken competitive activities as their subject matter: Pietro Metastasio's libretto *L'Olimpiade* was set more than fifty times in the eighteenth and nineteenth centuries.⁷⁶ Only in the twentieth century did ludomusical events emulate the format as well as the theme of ancient competition, however. Pierre de Coubertin's revival of the Olympic Games featured composition among a lineup of artistic contests staged from 1912 until 1948. (With the notable exception of the silver medalist Josef Suk [1932], the entrants have generally failed to trouble the scorekeepers of music history.)⁷⁷ Drawing on explicitly ludomusical works by composers such as Charles Ives, Erik Satie, Arthur Honegger, Bohuslav Martinů, and Constant Lambert, Anthony Bateman argues that the codification and international dissemination of sporting protocols were coeval—if sometimes at odds—with particular brands of musical modernism, the testing of aesthetic and political limits, and the quasi-veristic imperative to reflect and incorporate the clamorous registers of early-twentieth-century urban life.⁷⁸

In the orchestral arena, Honegger sought musical analogs for the "savage, brusque, untidy, and desperate rhythm" that marked the "attacks and ripostes" of rugby; his eponymous symphonic movement (1928) followed in the programmatic

footsteps of Franz Berwald's sprightly depiction of a race (*Wettlauf*, 1842).⁷⁹ Meanwhile, the avid soccer fan Dmitri Shostakovich made good on his apocryphal description of the sport as "the ballet of the masses."⁸⁰ *The Golden Age* (1930), a satirical ballet set to a libretto by Alexander Ivanovsky, treats sport as a metaphor for class warfare and the international *agōn* of communism and capitalism, conducted via fair socialist means amid foul bourgeois chicanery.⁸¹

In the wake of *Battez Philidor!* (1882), an *opéra-comique* by Amédée-Jean Dutacq and Abraham Dreyfus featuring eighteenth-century composer and master player François-André Danican Philidor as the principal antagonist, the cerebral conflict of chess was subjected to numerous twentieth-century musical representations, most notably in ballets featuring anthropomorphized chessmen composed by Martinů (*Échec au roi*, 1930) and Arthur Bliss (*Checkmate*, 1937).⁸² The serial maneuvers of Stravinsky's *Agon* (1957) enacted both an abstraction and a politicization of agonistic dynamics: George Balanchine's choreography mapped the black and white of chessboard and keyboard onto the costumes, and even the racial identities, of its twelve dancers.⁸³

Beyond the aesthetic and historical ambit of modernism, and in their way more telling than the overt representations of ludomusical activity on which Schwab and Bateman focus, are instances in which music is associated with the performance as well as the scripting and staging of agonistic action. From Handel vs. Domenico Scarlatti to the two-player battle mode of Konami's *beatmania* digital games, the trope of the musical duel resonates by way of legendary contests based on the evaluation of *technē* at the keyboard.⁸⁴ Such contests tend to place a high value on improvisation as a measure of wit, ingenuity, and flexibility as well as skill: in competition, successful players read and respond to the game's shifting state and the actions of their opponents in real time rather than according to a script.⁸⁵ But conventional musical scores are also capable of prompting agonistic play, as is illustrated by Mozart's Sonata for Two Keyboards, discussed in Key 4–2. Rather than a "work," the score constitutes the written-out rules for a light-hearted two-player game that is at once collaborative and competitive. On paper, Mozart's meticulous rotation of thematic material between the two instruments might be seen to typify the "classical" virtues of balance and symmetry. In performance, however, it can give rise to feuding and jesting in equal measure: the evenhanded alternation of roles compels each keyboardist to play each phrase more beautifully, virtuosically, or wryly than the other.

Since this type of good-natured agonistic play is predicated on the mutual pleasure that arises through the sharing of ludic endeavor, it exposes certain limitations of Huizinga's approach.⁸⁶ In his book *Les jeux et les hommes* (translated as *Man, Play and Games*), Caillois applauded Huizinga's fundamental insight into the significance of play, but complained that Huizinga's privileging of *agōn* failed to do justice to the diversity of play's forms and functions. Via a searching critique of *Homo Ludens*, Caillois sought to arrive at a structural taxonomy

table 1 Roger Caillois's taxonomy of play. Adapted from *Les jeux et les hommes*, 91 (*Man, Play and Games*, 36).

	<i>agôn</i> (competition)	<i>alea</i> (chance)	<i>mimicry</i> (simulation)	<i>ilinx</i> (vertigo)
<i>paidia</i>	races fight athletics boxing fencing football billiards checkers	children's rhymes coin-tossing betting roulette lotteries	games of make-believe and illusion dolls masks disguises theater spectacle	whirling swinging riding waltzing carnivals skiing mountain-climbing
<i>ludus</i>	chess			tightrope-walking

of play.⁸⁷ He affirms Huizinga's view that play must be voluntary (one must choose to play, free from coercion, which disqualifies gladiatorial combat) and separate (insofar as play unfolds in spaces akin to Huizinga's magic circles, areas physically and epistemologically delimited from everyday life even though they constitute—and are constituted by—its material and social fabric). By insisting on the multifariousness of play, however, Caillois diverged from Huizinga's almost exclusive focus on *agôn*. Acknowledging the ludic history of probability (the calculation of which often involved the rolling of dice), Caillois stressed the uncertainty of play and the principle that its outcome not be knowable in advance.⁸⁸ (The stigma attached to those discovered to have breached this principle by cheating indicates the importance of regulation to all forms of play, whether imposed by explicit rules, customs, or taboos.) Caillois also drew attention to play's fictiveness, its disruptive and disorienting powers, and its disregard for productivity: the objective of a game is not to generate goods or capital, although they may be acquired or redistributed as a condition or consequence (as occurs in professional play and gambling, respectively).⁸⁹

Having established these defining qualities, Caillois presented a taxonomy of games and playful activities (recreated in Table 1) that classifies them according to their blend of formal attributes as well as the physiological and psychological states they engender. After addressing agonistic competition, Caillois accounted for games of chance and fortune (*alea*), the play of make-believe, simulation, and deception (*mimicry*), and the dizzying, unruly play of motion (*ilinx*).

While agonistic play has to do with the assertion of self, the exertion of power, and the dividing of participants into winners and losers, *alea* involves the abdication of the self to the arbitrariness of external events. Marsyas's reckless challenge to Apollo involved an element of *alea* in that the satyr could not have foreseen its outcome, despite his confidence in his own musical skills. Unfortunately for him, he was competing with Apollo, to whom belonged "the lots of the diviner and

... the seers,” as Callimachus observed.⁹⁰ Whether figured as the result of divine (im)providence in the name of necessity (the primeval goddess Ananke) or blind contingency (the tutelary deity Tyche), Marsyas’s fate was thus always already sealed: as Nietzsche put it, “we shake the dice box with iron hands; even in our most intentional actions, we do no more than play the game of necessity.”⁹¹

As Nietzsche implied, and as Rüdiger Campe has scrupulously documented, the ludic form of *alea* traces historical tensions between theological concepts of fate and mathematical calculations of probability. In Jacques Derrida’s formulation, the concept of play brings together chance and necessity “in an endless calculus,” combining the unknowability of fate with the quantification of likelihood: in refusing to submit one to the other, play challenges the notion of a divinely ordered universe.⁹² Much of the stigma attached to gambling issued from religious broadsides against games of chance such as the third-century *Liber de aleatoribus*, which warned that “the devil is always present at the dice table,” and Gerolamo Cardano’s *Liber de ludo alae* (ca. 1526)⁹³ For Paul Schleuse, Alessandro Striggio’s “madrigal comedy” *Il gioco di primiera* (1569) illustrates “both the pleasure and danger of gambling” by dramatizing the threat it poses to self-control and social decorum alongside the cunning ruses by which players attempt to control their destinies amid the thrill of uncertainty and risk: ultimately, communal harmony must be restored by way of a dance in which winners and losers all participate.⁹⁴ But while Striggio depicted card-playing as a form of social allegory, life itself could also be construed in terms of the arbitrariness and amorality ascribed to play: Chaikovsky’s operatic adaptation of Pushkin’s *The Queen of Spades* (1887) imbricates fortune, destiny, and the supernatural to underline the nihilistic credo that “life is but a game.”⁹⁵

Beyond depictions of card and dice games, aleatoric procedures have infiltrated the generation and realization of musical texts. As both compositional method and performative mode, the play of *alea* helps account for such music as John Cage’s *Music of Changes* (1951) and *Fontana Mix* (1958), the choose-your-own-adventure of Pierre Boulez’s Third Piano Sonata (ca. 1955–63), Witold Lutosławski’s *Jeux vénitiens* (1961), and the triple-LP box set of Henri Pousseur and Michel Butor’s opera *Votre Faust* (1973), which included game boards, playing cards, and a spinner that enabled listeners/players to determine the course of musical events.⁹⁶ Despite the vast differences in their ideological and aesthetic underpinnings as well as their means of prompting and determining sonic consequences, the epistemological principles of all such texts can be traced back via the paper machinery of eighteenth-century musical dice games (*Würfelspiele*), technological forebears and descendants of which are examined in Key 3.

Caillois’s adoption of the English term *mimicry* emphasizes the playful, teasing aspects of mimesis, the etymological roots of which lie in μῖμος (*mimos*), meaning “mime,” “imitator,” or “actor.”⁹⁷ From Plato to Alan Turing by way of the sixteenth-century poet and historian Gregorio Comanini, the imitation games

of *mimicry* have tested the limits of resemblance and its intelligibility by way of pretense, illusion, and outright deception.⁹⁸ *Mimicry* suggests ways of theorizing the performance of identity via forms of imaginative role-play while calling attention to the representational strategies of media themselves. The late antique poet Nonnus reported that when Marsyas's hanging hide was transformed into a wind-bag, "the breeze often entered, swelling it out into a shape like his, as if the shepherd could not keep silence but made his tune again."⁹⁹ The "as if" of Nonnus's poem brings out the subjunctive mood of myth and its generativity as a playful simulacrum, at once real and imaginary.¹⁰⁰

Even as we lament Marsyas's violent demise we can, like Philostratus the Younger, delight in its fictive status and the play of its many representations. Describing a painting of the fateful instant before Marsyas's death, Philostratus drew the viewer's eye to the dread of the satyr, the serene joy of Apollo in his moment of victory, and the savagery latent in the knife-grinder about to administer punishment on the god's behalf. Last, but not least, Philostratus bid the viewer pay attention to Marsyas's fellow satyrs, who, as they tearfully lament his fate, cannot help but exhibit "their playful spirit and their disposition to leap about."¹⁰¹

Through this inferred behavior, the chorus of satyrs embodied the tragicomic register typical of the satyr play, a theatrical form often inserted within or following a sequence of tragedies that performed a comic function somewhat akin to that of the eighteenth-century operatic *intermezzo*. (Needless to say, opera writ large evinces an intense engagement with fictive play through *mimicry*: its masks, costumes, pyrotechnics, and other theatrical accoutrements shore up its demand that the audience suspend the disbelief occasioned by its flagrant violations of veristic behavioral norms.) The comic elements of satyr plays did not typically reside in the action itself, which typically unfolded in line with the tragic dynamics of mythical narrative. Instead, they emerged from the subversive relation of the chorus of satyrs to the high drama they were witnessing, as was the case regarding Philostratus's ekphrasis of the painting of Apollo vs. Marsyas. While the exuberance of satyric drama was most obviously manifested via bawdy props and skits, the playfulness of satyr plays also emerged from the multiple levels of their theatricality, the back-and-forth between role and actor as well as protagonist and chorus. For Philostratus, such metaplay was a mode of engagement derived from—and formed by—arbitrary yet reciprocal relations between subjects and objects often operating at cross-purposes to normative vectors of signification, interpretation, and even morality. Just as the player is also played, the actor is also acted upon according to the analogical dynamics of theatrical *mimicry*.¹⁰²

As illustrated in Figure 1, the ludic category of *ilinx* is also satyric and subversive insofar as it embraces behavior that is animalistic, intoxicating, and libidinous. If agonistic play has to do with challenging others, then *ilinx* tests—and often exceeds—the limits of the self, engendering risky behavior that the transformation of Marsyas's



Figure 1. Dancing satyr with auloi and case. Tondo of an Attic red-figure plate by Epiktetos, ca. 520–00 b.c.e. (Vulci, Etruria). Département des Monnaies, Médailles et Antiques de la Bibliothèque nationale de France (De Ridder 509).

hide into a wineskin at once bemoans and celebrates. Caillois took its name from ἰλινξ, a term connoting the whirling of maelstroms that reflects both a relation to the spinning tops associated with *alea* and a vortical propensity to “destroy the stability of perception and inflict a kind of voluptuous panic upon an otherwise lucid mind.”¹⁰³ The play of *ilinx* is frenzied and carnivalesque, like the orgiastic rites associated with the goddess Cybele in Phrygia, whence Marsyas hailed. Its emphasis on risk-taking and self-abandonment allies *ilinx* to the virtuosic display of musical kineticism, the disorienting effects of which are readily transmissible to others (as demonstrated by the mania induced by charismatic performers from Liszt to the Beatles and beyond). Issuing from and yet eclipsing the body’s sense of itself, *ilinx* eliminates the reflective distance between artistic stimulus and corporeal response, rendering aesthetics a strictly physiological matter. It stands for a Nietzschean state of ecstasy “in which sounds, rhythms, and dance figures . . . emerge and vanish endlessly,” short-circuiting the representational strategies of symbolic signification¹⁰⁴

In terms of form as well as function, *ilinx* becomes musically tangible in the whirling motion of dances (as noted by Eric McKee in the context of the late eighteenth century), the rough-and-tumble of spirited finales, the overtly ludic genres of the scherzo and *badinerie*, and the quicksilver whimsy of the capriccio.¹⁰⁵ Since

ilinx issues both from repetitive, rhythmic motion and from its unpredictable disruption, the distinction between its enactment and its representation is difficult to draw. In the case of his boisterous scherzos, Beethoven apparently relished the fact that depictions of *ilinx* were also liable to engender it.

When, especially in the scherzos of his symphonies, sudden, unexpected changes of tempo threw all into confusion, [Beethoven] would laugh tremendously, assure the men he had looked for nothing else, that he had been waiting for it to happen, and would take almost childish pleasure in the thought that he had been successful in unhorsing such routined orchestral knights.¹⁰⁶

Bizet's *Jeux d'enfants*, a set of twelve miniatures for piano duet, invokes the same phenomenon via its mesmeric presentation of the oscillation of a swing and the rotation of a spinning top alongside the more rambunctious ludic experiences of leapfrog and blindman's bluff¹⁰⁷ But while Beethoven's scherzos rejoice in thigh-slapping humor and Bizet's assortment of toys and games is bathed in a nostalgic glow, other manifestations of *ilinx* are darker. György Ligeti's vertiginous piano études, for instance, disorient the listener via the Escheresque manipulation of musical pitch-space and dizzyingly complex metrical layering: for all concerned, their impact in performance derives from the rapturous (con)fusion of bravery and terror in the face of physical demands that are at once perfectly logical and profoundly irrational.¹⁰⁸ From the waltz to the mosh pit, the unbridled power and attendant risks of *ilinx* are often framed by buffer zones and mitigated by safety nets that, like magic circles, are at once socially, materially, and ideologically constituted.¹⁰⁹

Across all four of Caillois's categories, a perpendicular axis of play measures the degree of *paidia* and *ludus*.¹¹⁰ *Paidia* represents the player's childlike delight in defying or simply ignoring constraints, and the pleasure taken in tumult, improvisation, and contrary behavior (somersault-turning, thread-pulling, or queue-jumping, for instance). *Ludus*, conversely, indexes the player's willing submission to the nonnegotiable rules that govern the pursuit of games and registers the pleasure taken in confronting—or ingeniously circumventing—arbitrary and recurrent obstacles (as in crosswords or Sudoku puzzles, for example).¹¹¹ The *paidia-ludus* continuum reflects social mediation and the player's psychological state as much as it characterizes activities themselves: even chess, which for Caillois is paradigmatic of *ludus*, can be played with a devil-may-care, indifferent, or actively disruptive attitude that introduces an element of *paidia*.¹¹²

Thinking in terms of *paidia* and *ludus* can open up fresh perspectives on the roles played by rules and regulations, whether internally or externally mandated and whether obeyed or flouted. In *Sports et divertissements* (1914), an album containing twenty-one piano pieces adorned with handsome illustrations of ludic activities, Satie resisted the tyranny of forced enjoyment by conveying the *ennui* of play and leisure when smilingly imposed by social convention. In part, these metaludic strategies can be read into Satie's willful refusal to adhere to the usual

protocol governing music's mimetic relations with images and ideas: in ironic contrast to the approach adopted by Bizet, he undercut the very notion of coordinating ludic motions with appropriate musical inflections.¹¹³ As is typical of *paidia*, Satie played with the rules rather than by them. In the collection's final piece, "Le tennis," the game (such as it is) emerges from the discrepancy between the musical figures scattered across the page and the laconic dialogue overlaying them, which makes it clear that erotic subtexts are far more compelling than Major Wingfield's rules of play.¹¹⁴ The same could be said for Debussy and Vaslav Nijinsky's ballet *Jeux* (1913) in which tennis serves merely as a metonymic pretext for amorous encounters, although Debussy cultivates a much more intimate relationship between the sensuality of (fore)play as manifested via the subtle dynamics of oscillation, undulation, repetition, and variation.¹¹⁵

The Kantian discipline of *ludus* emphasizes that structural beauty and complexity can be achieved both despite and owing to strict constraints. Cultural artifacts that display such qualities include architecture, textiles, origami, mathematics, canons, puzzles, and computer code: they generally emerge from and represent systems that are both governable and circumscribable by rules that are at once logical and arbitrary. In this respect, the rationality of *ludus* is closely associated with the codification of game theory by John von Neumann and Oskar Morgenstern. Their *Theory of Games and Economic Behavior* (1944) enabled social and economic interactions to be comprehensively formalized in terms of strategies designed to confer optimal advantages to rational players of zero-sum games. By articulating the mathematical rules governing agonistic encounters from courtship to war games, a group of scholars including von Neumann, Morgenstern, and the mathematician John Nash established the algorithmic logic that proceeded to guide diplomatic and military strategies throughout the Cold War. In ludomusical terms, this type of play is most directly found in Iannis Xenakis's *Duel* (1959) and *Stratégie* (1962), which pit two orchestras and conductors against each other: their scores are calculated from the particular combinations of musical modules chosen by each, and at the end the audience salutes the victors.¹¹⁶

The discipline imposed by *ludus* and its relation to education, edification, systematization, and order can be directly gleaned from the games of tones devised by Samuel Scheidt (*Ludi musici*, 1621), Josef Hauer (*Zwölftonspiele* 1939–59), and Paul Hindemith (*Ludus tonalis*, 1942) as well as from the development and deployment of arcane isorhythmic and contrapuntal techniques. Rules are omnipresent, as Foucault observed: their epistemological and material codes of conduct govern the behavior of human bodies as well as social systems and relations.¹¹⁷ Like the laws of chance, such rules emerged from theological doctrine, most obviously in the form of monastic *regulae*, before gradually forming the basis of philosophical, mathematical, and musical early-modern thought, as manifested by texts such as Johann Joseph Fux's *Gradus ad Parnassum* (1725).

In the nineteenth century, such rule-bound systems came under sustained attack. A staunch advocate of both *ilinx* and *paidia*, Nietzsche was equally averse to the formulaic application of rules and to Hegel's opposition of "child's play" to the pursuit of artistic truth: he defined maturity as the recapturing of "the seriousness one had as a child at play."¹¹⁸ Channeling Heraclitus while wreaking havoc on Kant's configuration of freedom, purposiveness, and play, Nietzsche claimed that "absolute free will can only be imagined as purposeless, roughly like a child's game or an artist's *Spieltrieb*."¹¹⁹

In this world, only play, play as artists and children engage in it, exhibits coming-to-be and passing away, structuring and destroying, without any moral additive, in forever equal innocence. And as children and artists play, so plays the everlasting fire. It constructs and destroys, all in innocence. Such is the game that *aiōn* plays with itself. Transforming itself into water and earth, it builds towers of sand like a child at the seashore, piles them up and tramples them down. From time to time it starts the game anew. . . . Not hubris but the ever self-renewing impulse to play calls new worlds into being.¹²⁰

At first glance, *paidia* seems closely bound up with Dionysian qualities, allied with Marsyas against the Apollonian attributes of orderly *ludus*. Yet the capricious behavior described by Nietzsche invokes Apollo's deadly destruction of an Achaean rampart during the Trojan War, which Homer likened to a child's petulant demolition of a sandcastle.¹²¹ It is Apollo, not Dionysus, who ruthlessly bears out the claim of Plato's Athenian stranger that humans serve as divine playthings and should behave accordingly, echoed by King Lear's rueful remark that mortal fate is no more than divine caprice: "As flies to wanton boys are we to th' gods./ They kill us for their sport."¹²² *Accordingly, the question of whether play is tragic or comic, profound or whimsical, has always been a matter of perspective as well as scale.*¹²³ Like Schlegel, Nietzsche suggested that the logic of *ludus* persists across cycles of creation and devastation: "The child throws its toys away from time to time—and starts again, in innocent caprice. But when it does build, it combines and forms its structures regularly, conforming to inner laws."¹²⁴ Rather than being opposed, *paidia* and *ludus* keep each other in check—and thereby in play.

1–2 BEYOND WORK AND PLAY

Throughout Western thought and culture, play's checkered history can be related via its shifting antonyms: earnestness, utility, efficiency industry, labor, and, above all, work. In the nineteenth century, these antonyms conspired to put play on the defensive. Play was feared, demeaned, and infantilized for representing a subversive threat to the work ethic that, as Max Weber grimly observed, drove the twin pursuits of spiritual salvation and economic growth.¹²⁵ As Bill Brown

points out, Huizinga's insistence on play as a fundamental principle that precedes its antitheses must be balanced against Herbert Marcuse's contention that precisely insofar as play marks "a breaking off from labor," it betrays its roots in work.¹²⁶ In terms of nineteenth-century music, the production of the reified musical work, personified by the Herculean figure of Beethoven and borne out by the transformative effects of his compositional labors, stands as evidence for Marcuse's argument: painstakingly documented and represented by *thematische Arbeit*, the work regulates, and even justifies, the instrumental play that fleetingly animates it.¹²⁷

Gooley has shown that Robert Schumann progressively distanced himself from *ex tempore* play at the keyboard as a primary form of creative activity, stressing instead the virtues of conceiving and elaborating musical designs as a purely mental process.¹²⁸ Despite his own youthful indulgence in six-hour improvisatory marathons, in 1838 Schumann warned his wife-to-be Clara "not to improvise too much" since valuable material "gets uselessly lost that way."¹²⁹ Gooley accounts for this shift in terms of the burgeoning "moral economy of the German bourgeoisie," which insisted on the evidence of tangible productions wrought via compositional thrift and motivic efficiency.¹³⁰ Even at the turn of the century, the rise in the aesthetic stock of instrumental music, reflected by Tieck, Michaelis, and Nägeli, had been coeval with disparagement of its means of production. Goehr notes that at the hands of Herder, performance was associated with "impure labor" and instruments became synonymous with lowly tools (*Werkzeuge*) that were put to artificial ends.¹³¹ In Goehr's reading, such instrumentophobia reached its apex with Wagner's *Die Meistersinger*, the *agōn* of which reassigns aesthetic and political power from "those who perform upon [instruments] in favor of those who become them," from those who merely play to those who prove themselves worthy of being played by a higher power.¹³²

In the face of concerted attacks from Wagner and his supporters, who followed the lead of Herder and Hegel in targeting play's virtuosic instrumentality and meaningless formalism, the articulation of play as a viable aesthetic mode required the appropriation of its detractors' critical weapons. It was in this spirit that Eduard Hanslick appealed to his readers' memories of childhood when praising instrumental music's purposive, kaleidoscopic "play with colors and forms," treating such activity not as autonomous but rather as evidence of (and stimulation for) human consciousness and creative cognition.¹³³ Although Hanslick's Kantian definition of music as *tönend bewegte Formen* echoes Nägeli's emphasis on music's *Formenspiel* and anticipates the tautologically gnomic terms in which Gadamer would define play as "the self-representation of its own movement," it was nonetheless born from the Herderian conviction that these motions resonated with "the great motions of the universe" as well as the tremors of the soul.¹³⁴

The dazzling play of the virtuoso left Hanslick cold insofar as its exploitation of corporeal techniques and sensations left precious little to the imagination: while he sought to distance music from language, function, and utility, he nonetheless insisted on its spiritual as well as its aesthetic attributes. In this sense, Hanslick's attitude neatly reciprocated that of his nemesis Franz Brendel, who backhandedly acknowledged Kantian aspects of musical play even while insisting on the primacy of programmatic texts and concepts.¹³⁵

Weber connected the elevation of the work ethic and concept with the rise of Protestantism and industrialized capitalism, implicating both in the rational and systematic development of institutions and instrumental technologies such as the symphony orchestra, the hierarchical organization of which precluded improvisatory play and other informal interactions. Huizinga adopted a similar line, bemoaning the effects of industrialization that had weakened play's ritual force and communal functions. While the narratives of Weber and Huizinga recapitulated Schiller's nostalgia for an older, purer world in which play was unsullied by material considerations, Weber's analysis also registered the discursive effects of historical musicology, in which music was understood primarily in philological terms as a library of texts in need of ontological grounding beyond their functions as cultural scripts. J.Q. Davies argues that the concept of the musical work only became imaginable in an age of mass reproduction, since the disenchantment wrought by ubiquitous commodification brought with it the implication that music's essence must reside elsewhere.¹³⁶ Analogously, the anxiety shared by Herder, Schiller, Wagner, and Hanslick concerning the rational, mechanical aspects of instrumental play simultaneously obscures and reveals the extent to which Romantic aesthetics relied on them, if only as a point of departure.

Unlike the relationship between singer and song in *Die Meistersinger*, the ludic oscillation between playing and being-played is subject to inversion at any moment: it can bypass intention, consciousness, and even life itself (as Nonnus's description of Marsyas's resonating hide suggests). For Caillois, as for Weber, such meaningless fluctuations were at odds with the pragmatic commitments to productivity and utility that underwrite the moral and economic codes of industrialized societies: "Nothing has been harvested or manufactured, no masterpiece has been created, no capital has accrued. Play is an occasion of pure waste: waste of time, energy, ingenuity, skill, and often of money."¹³⁷ Yet the liminal forms of play that unfold at society's fringes, even those implicated in immorality, corruption, and dysfunction, also lie at the heart of "civilization."¹³⁸ Agonistic conflict, competition, and cheating thrive in the economic and educational systems; speculative gambling fuels the stock market; and codes of costume and conduct legitimize institutional power in the guises of dress-up (uniforms) and role-play (etiquette).

This exposes the economic, sociological, and psychological stakes of describing an activity as either “work” or “play.” According to the *Oxford English Dictionary*, work moves objects through effort and exertion, while in play they oscillate and revolve freely; work transforms things from one state into another via laborious activity, while play involves quicksilver changes from one state to another and back again; work is tiresome while play is pleasurable; work is real while play is make-believe; and work has to do with the production of tangible artworks, whereas play has to do with the (re)enactment of drama and music.¹³⁹ Yet how can we explain the fact that the very conditions and characteristics that make play enchanting—repetition, entrainment, the enforcement of rules typical of *ludus*, the tumult of *paidia*—can be indistinguishable from those that make work arduous and tedious? As Tom Sawyer discovered when confronted by a fence that needed to be painted, there is nothing intrinsic about an activity that defines it as either “work” or “play”: it is categorized as such according to the values, functions, and imperatives that govern whether and how it is performed.¹⁴⁰ The criteria by which “work” and “play” are told apart shed as much light on the esteem and stigma attached to a particular activity as on the activity itself.

In their influential schematic representation of play, digital game theorists Katie Salen and Eric Zimmerman reflect this state of affairs by concentrically nesting “game play,” “ludic activities,” and “being playful.”¹⁴¹ At the center lies the relatively narrow definition of “game play” as the formalized interactions that take place when players experience the logic of a ludic system through play (as in an organized game of baseball, for example). Moving outward, “ludic activities” accommodate behavior that is not bound by formal rules but that incorporates ludic elements (such as an impromptu game of catch). At the periphery, “being playful” implies a playful attitude or modality that can be applied to ostensibly non-ludic situations or actions (such as popping bubble wrap, dressing up, or painting a fence) as well as to the playing of games themselves. In Salen and Zimmerman’s neo-Kantian formulation, play “takes advantage of the space of possibility created from the system’s structure”: it owes its existence to rigid rules or material constraints, but takes place despite—and sometimes in opposition to—them.¹⁴² This type of relation accounts for both the orderly principles and the stochastic flow of a soccer match or a bebop performance, in which the ludic distribution of agency among and between actors, objects, rules, and strategies is clearly apparent, even (and perhaps especially) when those rules are being breached.

For Foucault, the task of representing such principles and agencies was both archaeological and genealogical: it had to do not only with the affordances and restrictions of particular systems of thought (*épistèmes*), but also with their temporally shifting formations. Foucault believed the generation and storage of knowledge to be governed by epistemological rules distinct from those that regulate grammar, logic, and history. While these rules delimit conceptual possibilities,

they both effect prohibition and enable transgression via vectors of power and discipline that, in conspicuously ludic terms, rehearse the dynamics of *agōn*, “the endlessly repeated play of dominations” and its associated maneuvers, tactics, and techniques.¹⁴³ Adopting and adapting the term from Nietzsche, Foucault claimed that genealogy eschews the purposeful teleology associated with work, uncovering ludic recurrence where others sought evidence of serious historical progress. Genealogy “operates on a field of entangled and confused parchments, on documents that have been scratched over and recopied many times.”¹⁴⁴ It traces archaeological methods as well as remains, taking as its subject matter not only archival evidence, but also the discursive formations of the archive itself, which constitutes “the set of rules governing the range of what can be verbally, audiovisually, or alphanumerically expressed,” as Wolfgang Ernst puts it.¹⁴⁵ Ludomusical fields of play are Foucauldian palimpsests that at once enable, regulate, and erase the inscriptions of bodies in motion: rather than determining specific outcomes, the prevailing rules provide a framework within which a range of possible outcomes becomes imaginable and simulable.

Although indebted to Foucault, Ernst’s technical terminology leads away from the *épistème* and toward Kittler’s *Aufschreibesystem*, which Kittler defined as the assemblage of technologies and institutions “that allow a given culture to select, store, and process relevant data.”¹⁴⁶ By focusing on media mechanisms and techniques, the work of Kittler and Ernst draws attention to the material conditions that make an utterance, transcription, or genealogical palimpsest possible. This is particularly important when it comes to ludomusical praxis, since games and music cannot be directly accessed from within an archive or repository: insofar as their documentary remains are always static and fragmentary, their reanimation requires technologies of recreation (bodies, instruments, and other devices) as well as textual modes of transmission.

In humanistic scholarship, the archive has typically provided the lettered basis for recovering the past through the activation of the literary imagination. For music, as for theater, an analogous function is performed by the corpus of texts grouped under the rubric of a repertoire, which serves to index the conceptual range and limits of a particular form of cultural praxis. Emanating from the field of performance studies, recent debates over the ontology of audiovisual materials and their functions as documents of the performed past have given rise to new formulations of relations between archive and repertoire, text and performance, event and trace.¹⁴⁷ As a challenge to the nomological imperative of the archival record, which guides and ratifies accounts of the past insofar as they form sums or subsets of its documentary evidence, Rebecca Schneider has explored how the embodiment of remembered or imagined experience under the simulative rubric of reenactment can itself constitute a form of historical substantiation when performed and recorded.¹⁴⁸ Her work problematizes distinctions between

texts, acts, and material evidence, suggesting new ways in which we might register performance and the technologies deployed to capture it.

From another perspective, acknowledging the drastic power of acts in and as performance involves locating them within Vismann's chiasmic syntax of media. To understand how bodies store and transmit cultural knowledge, we must apprehend how communicative media are themselves materialized and physiologically embedded, which opens the archive to media-archaeological forms of inquiry. Georges Didi-Huberman claims that the past "can impose itself as an alienating element of . . . historical interpretation itself."¹⁴⁹ Via historical research, we "gain access . . . to the subtleties of a given period, which we then try to *understand through its own intelligibility*. But we must also know how to smash the ring . . . , insofar as we want to *understand the intelligibility itself*."¹⁵⁰ To this end, Ernst highlights the predominance of historiographical metaphors that frame the flight of time's arrow in the organic terms of embryonic development, maturation, and senescence.¹⁵¹ Such narrative strategies emerge not merely from the chronological ordering of events, but from the logic of the alphabet and the cultural techniques of literacy that naturalize the serial concatenation of words and events alike.

In recent years, digital humanists of various stripes have demonstrated that numbers (and numerical procedures) can supplement letters (and literary theory) in accounting not merely for inscriptive techniques, but for the sequencing of cultural operations writ large. In the contexts of communication and bureaucracy, Siegert notes that while ink and paper might primarily be associated with the development and dissemination of literary content, they have also been implicated in networks based on signals rather than utterances, relays rather than communications, and instructions rather than expressions.¹⁵² Similarly, Markus Krajewski's intellectual history of the card catalog draws structural analogies between "index cards and bank notes, house numbers and book shelving, card catalogs and Turing machines."¹⁵³ Krajewski frames these various exempla of informational technologies as "paper machines," a maneuver that can be read in terms of Foucault's genealogical palimpsests. Chronological contiguity alone cannot account for the observability of isomorphic relations between disparate instantiations of the same technological and epistemological principles. Tracing such techno-epistemological strands through time and space while remaining steadfastly in the present tense, Krajewski self-consciously deploys the rhetorical strategy of catachresis, which he defines as "a failed transfer, a juxtaposition of incongruous elements" that produces "a surplus of meaning that stimulates thought" as it makes explicit the fictiveness of the historiographical mode and its imputation of cause and effect.¹⁵⁴

As Krajewski shows with regard to Gottfried van Swieten (Prefect of the Viennese Imperial Library, inventor of the card catalog, and patron of Haydn and Mozart), the principles and means of organizing knowledge can be named and described via the retrojection of latter-day technical terminology even as they are

grounded in their native historical milieu.¹⁵⁵ At once revealing and demonstrating the multiplicity of the means by which cultural techniques can be represented, such maneuvers reconfigure temporal and cultural distance as space to be negotiated by contemporary and historical observers alike.

By ultimately returning to the trope of history as fiction, Krajewski becomes embroiled once more in the literary terms from which he departed, just as his provocative thoughts on paper machinery are nonetheless framed and bound in the traditional format of the book. But Krajewski's literary feedback loop suggests a means by which the playing of *musical* texts, which have long been recognized to blur the boundaries between expressive utterance and performative instruction, might offer alternative modes of navigating beyond the realms circumscribed by literary tropes of signification and meaning. Such texts themselves can be apprehended as paper machines, as algorithmic programs that order and process information via ludomusical play.¹⁵⁶

Ghiselin Danckerts's *Ave maris stella* (1535, Figure 2) is a puzzle canon presented in the form of a chessboard, on each square of which is notated a musical fragment. According to Hans Westgeest, who claimed to provide the first comprehensive solution in 1986, twenty viable four-voice motets in addition to *Ave maris stella* can be derived by partitioning and navigating the board in various ways.¹⁵⁷ As well as representing a game, Danckerts's canon constitutes one: it operates as a paper machine that guides and regulates the moves of its players in nonlinear and yet systematic ways in order to produce multiple viable musical outcomes. As a field of play, the chessboard is thus capable of staging the devising and execution of ludomusical strategies, a relationship observed by the chess-loving violinist in Vladimir Nabokov's novel *The Defense*: "What a game, what a game. . . . Combinations like melodies. You know, I can simply *hear* the moves."¹⁵⁸

The epistemological common ground shared by Danckerts's chessboard, an allegorical fifteenth-century illustration of a checker, eighteenth-century *Würfelspiele*, and contemporary digital games will emerge over the course of the Keys to come. For now, these disparate phenomena are grouped together not only to indicate a particular lineage of contemporary ludomusical praxis, but also to suggest that modern technologies and discourses might provide a catachrestic lexicon with which to describe objects and techniques that are temporally and geographically remote but morphologically related.¹⁵⁹ In this sense, musical scores might be understood not merely as quasi-literary utterances or architectural blueprints, but as sets of rules based on the play of correspondences between signs and actions, *graphē* and *phōnē*, *logos* and *technē*. Analogously, and reciprocally, digital games can be apprehended in terms of the ludomusical performances they prompt and regulate.

To this end, Krajewski's deployment of catachresis can be supplemented by the concepts of retronymy and skeuomorphism. A retronym is a term introduced to distinguish a long-standing object or practice from successors that bear the same

GHISILINVS DANCKERTS,
 QVATVOR VOCVM,
 VNIO.

C A N O N.

QVOD APPOSITVM EST. ET APPONETVR.
 PER VERBVM DEI BENEDICETVR.
 SAPIENTI PAVCA.

Auguste Vindelicozum/Melchior Kriegstein/Excudebat/ Anno/ꝛ. XLIX.

Figure 2. Ghiselin Danckerts, *Ave maris stella* (Augsburg: Auguste Vindelicozum and Melchior Kriegstein, 1549 [originally published in 1535]). Reproduced by permission of the Herzog August Bibliothek, Wolfenbüttel (186 Musica div. 2°, fol. 1).

name in spite of decisive technological transformations that are masked by lexical continuity. In the wake of electrification and recording, for instance, a guitar or a musical performance must be retronymically qualified by the prefixes “acoustic”

or “live,” respectively. Conversely, a skeuomorph is a derivative object that retains ornamental design cues to elements that used to be—but are no longer—integral to its structure or operation. While retronyms recognize and sharpen distinctions between the past and the present, skeuomorphs smooth them over, and yet the identification of either is predicated on the assumption that phenomena change over time in line with a logic of supersession and obsolescence.

From a media-archaeological perspective, the insights of retronymy and skeuomorphism can be combined to form the concept of the *reverse* skeuomorph, which Alan Liu defines as a feature that seems ornamental, coincidental, or inessential in historical terms, but that proceeded to assume structural significance in concepts, practices, and objects derived from it. Such “prophetic relics,” as Liu calls them, “are epistemological rather than instrumental stitches between past and present. They are an index or placeholder (rather than cause or antecedent) of the future.”¹⁶⁰ Once they have been situated as such, the process of navigating between these indices and placeholders becomes recursive, as Geoffrey Winthrop-Young observes vis-à-vis Krajewski’s work: tracing their genealogical relations transforms their historical contexts, which in turn alters their status and significance in the present.¹⁶¹ Instead of ordering events in a series governed by the logic of antecedence and consequence, the cross-referencing of such indices configures them in terms of prolepsis and analepsis: they come into being by shuttling between the not-yet and the always-already.¹⁶²

Historical instances of ludomusical mechanisms often take the form of reverse skeuomorphs insofar as their distinctive attributes were later identified as such under drastically different techno-epistemological conditions. At the same time, since contemporary digital games are themselves thoroughly historical phenomena, the playing of such games and the music they enact, recreate, and prompt can retool our understanding of ludomusical activities that are stranded in the past. To take two examples to be discussed toward the end of this Key, digital gameplay suggests how performances of Chopin’s “Minute” Waltz can be construed as speedruns and how chamber music might be played as an asymmetrical cooperative multiplayer game.¹⁶³ In part, such juxtapositions are whimsical gambits designed to jar the reader into taking their implausibility seriously. At the same time, they constitute an attempt to recognize the historicity and coexistence of performative aspects of ludomusical play that stubbornly elude literary description and are thus absent from the historical record. On yet another level, they lodge a deeper claim concerning how information becomes conceivable and transmissible via digital means of arraying and accessing it.

In this light, it is notable that it took more than three hundred years for a comprehensive solution of Danckerts’s puzzle to be registered, indicating that it resonated in sympathy with twentieth-century ludic mechanisms. For Nabokov’s violinist, certain rare sequences of ludic moves could be both tactically irresistible

and aesthetically harmonious; the elusiveness of such combinations are reflected by the fact that the sixty-four squares of the chessboard also formed a test bed for problems involving permutational and exponential functions.¹⁶⁴ Inquiry into the means by which an unfathomably large range of patterns could be algorithmically generated from a relatively small collection of fixed elements was pursued under the logic of the *ars combinatoria* first described—and materialized by way of paper machines—by Ramon Llull at the turn of the fourteenth century.¹⁶⁵ More recently, Deep Blue’s digital computation of optimal chess strategies involved brute-force combinatorial calculations as well as reference to a vast library of previous games.

Such processing also informed the ludic turn taken by poststructuralist thinkers such as Derrida, for whom the permutational mechanics of play worked against the logic of totalization, the establishment of centers, the pursuit of origins, and the construction of unequivocal meaning: ludic infinitude was constituted by the endless serial interplay of discrete elements, whether notes or letters.¹⁶⁶ In a similar vein, Barthes noted that textual play opens up infinite possibilities while sidestepping the ineffable, just as it is generative without being productive.¹⁶⁷ For Barthes, play was the means by which text could mobilize and propagate in the face of potential ossification into a work fit only for philological or hermeneutical exhumation.

Significantly, Barthes—an amateur pianist as well as a lover of games—invoked music as a paradigm for the collaborative process of “play[ing]” a text, of “*mak[ing] it go*.”¹⁶⁸ For Huizinga, the performance of music and the *fort-da* of its rhythmic unfolding were indispensable to the very notion of artistic play; for Laurence Dreyfus, the dream of “unfettered play” offers reciprocal access to “music’s greatest joy.”¹⁶⁹ In different ways, all three divert attention away from the cultural functions that texts, games, and music fulfill and toward how they (enable people to) play by investing actions with transformative power. In this light, the rules of musical play can be understood as performative as well as discursive. Similarly, its materials are subject to social and historical flux while also forming structures that obtrude, resisting straightforward assimilation by progress, entropy, and other narrative strategies. Treating play as principle and mode as well as object of inquiry, we might deploy other means of tracing the forces that have shaped particular forms of play over time. Rather than attempting simply to describe ludomusical play, we can set out to transcribe the rules, both tacit and explicit, according to which it has been imagined, materialized, mediated, and experienced. Along the way, we might register play’s idiosyncrasy and promiscuity, its violence and its rapture, its carefree yet contingent transgression of the boundaries drawn between divine, human, animal, natural, and mechanical realms.

Any instance of play can be historically indexed and situated only once its formal properties have been identified; conversely, such properties assume significance only

when embedded in the historical and cultural milieux that furnish the terms on which their legitimacy is granted, demonstrated, and questioned.¹⁷⁰ If, as Dreyfus suggests, the playful oscillation between seemingly incommensurable criteria can obviate the temptation to subjugate one set to the other, then the keyboard's most overtly ludic manifestations and associations offer the best chance of capturing the full range and variegated shades of its digital analogies, as explored in Key 2.¹⁷¹ Whether real or imagined, historical interactions between sweet fingers, blessed wood, and wiry concord can inform our understanding of contemporary ludic phenomena. Reciprocally, and in keeping with play's commutative logic, a full account of today's ludic environment, which is predominantly characterized by digital games of conflict (*agōn*), fortune (*alea*), role-play (*mimicry*), and sensory overload (*ilinx*), can enrich our attempts to construe how the musical past played out.

1-3 THE SOUND OF GUNPLAY

While all media reflect the material and ideological conditions under which they became conceivable, the case of the digital game is particularly revealing.¹⁷² The twenty-first-century media landscape has been profoundly shaped by the rise of games to an unprecedented level of cultural prominence. Most commonly registered through their seismic impact on the economic terrain of the global entertainment sector, digital games have transformed the stock of financial, symbolic, and social capital in which popular culture has traded since the late 1970s. Such games channel a dizzying array of preexistent art forms, media, and genres that includes calligraphy, painting, *manga*, *anime*, graphic novels, science fiction, board games, theater, opera, film, television, radio, advertising, recorded sound, electronic music, dance, and performance art. Fabricated as an unruly assemblage of technologies and delivered as a multipronged sensorial assault, the digital game indexes the *Gesamtkunstwerk* not only via its promiscuous (re)mixing of media, but also by the scope of its ambition, its susceptibility to violence and bathos, and its seductive promise of transcendence.¹⁷³

Whether as simulation or simulacrum, and whether it conceals its representational means or draws attention to them, the digital game symbolizes imaginary worlds in a subjunctive mood that discloses much about the fears and desires haunting the contemporary unconscious.¹⁷⁴ As dispatches from technology's front line in registers ranging from the defiantly subcultural to the elegantly neoclassical and the elaborately baroque to the self-consciously avant-garde, digital games have opened up new modes of representation, expanded the critical lexicon, and stimulated distinctive contributions to debates surrounding the visual arts, film, literature, and new media. In the wake of groundbreaking contributions by William Cheng, Karen Collins, K.J. Donnelly, William Gibbons, Miki Kaneda, Fares Kayali, Neil Lerner, Elizabeth Medina-Grey, Kiri Miller, Peter Shultz, Tim

Summers, Chris Tonelli, and a growing band of others, digital games have also begun to infiltrate the discourse and practice of (ethno)musicology, while their soundtracks have been analyzed by an increasingly sophisticated music-theoretical apparatus.¹⁷⁵ A chasm nonetheless yawns between the status of mainstream digital games—replete as they are with ugly stereotypes, pulpy plots, and violent action—and attempts to ennoble them with high-flown theory (despite the precedent set by Wagner, not to mention Greek mythology, on each of these counts). For Alexander R. Galloway, this rift is to be celebrated rather than bridged, for it reveals how the immediacy, vitality, and presence of digital games fly in the face of the taxidermic academic impulse.¹⁷⁶ Yet, as Pierre Bourdieu observed and Galloway's own work bears out, high theoretical stakes can on occasion be raised with particular acuity by “apparently mundane, if not derisory, objects.”¹⁷⁷

The digital game unites two of the furthest-reaching innovations of the twentieth century, both closely associated with von Neumann: the discipline of economic game theory, which he developed with Morgenstern in the years leading up to the Second World War, and the computer architecture developed in the postwar years that bears his name.¹⁷⁸ It should be no surprise, then, that the digital game has served as a lightning rod for debates concerning the representation of violence, the rationalistic quest for domination in zero-sum conflicts, and relationships between reality and simulation as well as human and machine: it stands in synecdochically for the economic, technological, and militaristic operations of late capitalism writ large.¹⁷⁹

A strain of ludic evangelism has countervailed the opprobrium piled upon digital games and those who play them. Jane McGonigal argues that games possess the potential to transform twenty-first-century lives for the better, teaching us how to enrich and inspire rather than—or as well as—how to “frag,” “troll,” and “grief” one another.¹⁸⁰ Conversely, Nick Dyer-Witheford and Greig de Peuter contend that the military technology that powers digital games and the ideologies of production and consumption that underwrite them expose their abject complicity in the workings of corporate capitalism and empire.¹⁸¹ From their Marcusean perspective, the freedom of play is merely a Trojan horse concealing the nefarious means by which games induce people to labor for scant reward. For those in positions of power, moreover, the playing of games becomes indistinguishable from gaming the system, with little heed paid to the ethical and environmental fallout that can accrue.¹⁸²

Just as interpretations of Apollo vs. Marsyas must negotiate the myth's ludic drama and its shocking violence, approaches to digital games must navigate between aesthetics and ethics when confronting the dystopian fantasies that they so often enact. Tellingly, the most provocative recent work in play studies has issued from digital game scholars whose research interfaces with critical theory and political activism as well as the praxis of game development. On the former

front, Galloway and Ian Bogost have focused on systemic, procedural, relational, and algorithmic aspects of games; on the latter, Bogost, Mary Flanagan, Celia Pearce, and Anna Anthropy have explored historical and political dimensions of the technologies that drive digital gameplay and its design, thereby elucidating the ideological forces that establish, enforce, and subvert its rules.¹⁸³ Collectively, their work takes account of how digital games operate and of the phenomenological and social experiences that they afford, demonstrating that the technical and representational means of digital games are thoroughly intertwined.

Players of digital games acquire literacy across an array of visual, sonic, tactile, and affective codes.¹⁸⁴ The syntax, grammar, and tropic logic of these codes can be processed semiotically through representations native to the digital game and those incorporated from other media. Players can choose whether to submit to a game's ludic logic, to circumvent it via exploits, to subvert it via forms of unconventional play, to redefine its constraints by altering its code, or to reframe its representational strategies and outcomes. The blending of simulation and mimesis that is so characteristic of digital games thus requires a bifocal approach. Mimesis interacts and interferes with the logic of simulation, creating a parallaxic play-space that can be perceived—and occluded—from multiple vantage points. The elements that define and distinguish the digital game have their own historical and epistemological lineages, but they also reflect the ecology in which games participate today, an ever-shifting environment that shapes the meanings derived from the processing of binary code and its modulation into signals that impinge on the human sensorium.

For the purposes of architects, sound engineers, surgeons, and drone operators as well as the players of games, computers calculate or approximate the relevant optical, acoustical, and geometrical data required to simulate environments via complex sets of rules. While doing so, the computer's central processing unit (CPU) is insensible to distinctions between different types of data, since all information must be transcoded into bits. In the terms of Luhmann's systems theory, the computer is "operationally closed" insofar as its relatively high levels of internal order and complexity rely on the identification and isolation of information from noisy environments according to strict protocols. But while it cannot communicate directly with those environments (as anyone who has sworn at a crashed computer knows all too well), a computational system is nonetheless deeply embedded in and promiscuously "coupled" with them by way of input and output devices that modulate information into stimuli to which both human and nonhuman actors can respond.¹⁸⁵ For the computer, a keystroke converts an alphanumeric symbol into a snippet of binary code; from a sensorial perspective, the digital distinctions supplied to and processed by the CPU can be represented as pixels or pitches, flashes or rumbles, animations or syncopations. Both despite and owing to its foundation on digital operations, the significance of such events

cannot be foretold or circumscribed, but rather emerges via the asynchronous and unpredictable collusion of artists, developers, hardware, code, interfaces, screens, speakers, and players.

Beyond its immediate history, media-archaeological fragments of the digital game are scattered among the mathematical and technological innovations of philosophers, inventors, and polymaths ranging from the ancient Greek philosopher and statesman Archytas to Filippo Brunelleschi, Leibniz, and Athanasius Kircher. As mathematician, acoustician, astronomer, engineer, strategist, and acquaintance of Plato, Archytas explored the calculability of sonic phenomena as well as the trajectories of airborne objects. In the early fifteenth century, Brunelleschi established geometrical optical linear perspective as a painterly technique, which was codified and demonstrated by his acquaintances Leon Battista Alberti and Masaccio. In the seventeenth century, Leibniz had a hand not only in the invention of binary, but also in the development of differential calculus, which offered a means of digitizing the continuous trajectories of bodies in motion and thus rendered them computable.¹⁸⁶ For his part, Kircher developed the *lanterna magica*, a forerunner to the slide projector that beguiled onlookers by throwing ghostly images of demons and skeletons onto walls.¹⁸⁷ As documented in his *Musurgia universalis* (1650), Kircher also developed combinatorial systems of music composition, codified modes of musical encryption, and worked on technologies related to mechanical musical recreation.¹⁸⁸

As Kittler pointed out with relish, a thread connects these innovations: all are related to the waging of war.¹⁸⁹ While Archytas's observations on the proportional relations between pitch and velocity may have been inferred from the aulos, they were equally applicable to the motion of projectiles on the battlefield.¹⁹⁰ Perspective, as deployed by Leonardo da Vinci and Albrecht Dürer, became a technological means of aiming firearms accurately. Similarly, the benefits of the capability to calculate the ballistic properties of cannonballs were an impetus behind Leibniz's development of calculus, while Kircher's *lanterna magica* and musical codes were conceived in order to transmit military intelligence over long distances. Through and beyond these examples, Kittler notoriously argued that all technologies of diversion owed their very existence to the war machine: "The entertainment industry is, in any conceivable sense of the word, an abuse of army equipment."¹⁹¹

Even with Kittler's militaristic bias set to one side, it is indisputable that digital games do not merely draw on an agonistic media-genealogical legacy, but were directly spun off from technologies initially developed for and by the US military-industrial complex. Correspondingly, the operations that govern them issued from the development of the earliest computers by von Neumann and his collaborators and competitors in the aftermath of the Manhattan Project, in which von Neumann played a critical role. This helps explain why the development of

the digital game was closely tied to the relationship between the United States and Japan, nations whose military and technological fortunes were bound together by conflict, trade, and cultural exchange

William Higinbotham's *Tennis for Two* (1958), one of the earliest electronic games made accessible to the public, illustrates these relationships and codependencies.¹⁹² Higinbotham had worked on the Manhattan Project before becoming head of the Brookhaven National Laboratory's Instrumentation Division, and his game was played not on a television but on a triggered-sweep cathode-ray oscilloscope. This analog display technology had been developed as a means of mapping the presence of invisible objects as identified by sound waves (sonar) or radio waves (radar); it was concerned with providing data that tracked sea- and aircraft for military purposes.¹⁹³ From its formative moments, then, the predigital video game traced the trajectory of Leibniz's calculus in dealing with representations of bodies in motion, whether they took the form of airplanes or tennis balls. (In this light, it is telling that Nijinsky had initially envisaged that his and Debussy's *Jeux*—which Higinbotham might have called *No Tennis for Three*—would conclude with a plane crash.)¹⁹⁴ *Tennis for Two* challenged players to process images in order to enter timely and accurate input that coincided with (and brought about) spatial collisions. The agonistic and violent qualities of such games were thus integral to their development rather than overlaid onto it. The repurposing of hardware for ludic purposes simply enacted a shift from the mimetic representation of external phenomena (such as airplanes) to the simulation of physical laws governing the motion of imaginary objects ("tennis balls") via analog or digital computation and the modulation of relevant data into audible or visible signals.¹⁹⁵

Although audio-related technologies from sonar to stereophony made contributions to the development of the computer and the waging of war, early digital games such as *Spacewar!*, developed by a team at the Massachusetts Institute of Technology in 1962, produced no intentionally musical sounds.¹⁹⁶ As Claus Pias observes, however, the very title of Atari's *Pong* (1972) signaled the supplanting of the relay clicks of *Tennis for Two* by the onomatopoeic bleeps and bleeps of audible sine waves: hardware designed for video display was repurposed to deliver sonic feedback that synchronized and represented the binary logic of colliding and missing through distinctions of frequency.¹⁹⁷ In human terms, these different pitches articulated the zero-sum representation of victory, defeat, and their ludic deferral.

When ballistic data were processed by the digital computational power of von Neumann's serial architecture rather than by televisual relays and gates, relatively complex artificially intelligent responses could be calculated and performed by the machine itself. This facilitated the pseudoapocalyptic drama of Tomohiro Nishikado's *Space Invaders* (1978), in which a lone human is pitted against endless waves of computer-controlled alien adversaries. In *Space Invaders*, it is immediately apparent that the computer has transformed from neutral arbiter into

implacable (and unbeatable) enemy: the phalanx of aliens unremittingly traverses and descends the screen in a pattern that emulates in slow motion the sweep of the electron beam that plots their bitmapped images. As the player reduces their number via laser cannon, the decreased load on the CPU accelerates their movement. This effect is matched by an increase in the tempo of the soundtrack's reiterated descending tetrachord that, in a positive feedback loop, both registers and stimulates the player's quickening pulse as the stakes rise.¹⁹⁸ The increased motion that accompanies the redistribution of the burden of execution from CPU to human is thus represented both visually and aurally.

As this synchrony suggests, the computer can both visualize auditory data and "sonify" visual data as commanded, and this media-agnosticism is often identified as a hallmark of the digital age. That notwithstanding, the mechanisms by which computers store and process binary information evoke Gotthold Ephraim Lessing's distinction in *Laocoön* (1766) between the "spatially juxtapositive arts . . . of painting, sculpture, and architecture, and the temporally progressive arts of . . . poetry and music," in Albright's paraphrase.¹⁹⁹ Bits are either stored as spatially divergent but temporally fixed structures of memory, or executed serially in temporal sequence as code. The static configurations of bits as memory can be correlated with the spatial properties of the image (and in some early computers they were even visible as such); the execution of bits as code and the resultant "syncopations of changes in registers," as Bogost describes them, are more closely analogous to the transformation of a score into a musical performance.²⁰⁰ Describing the CPU as a "sonic, highly rhythmical mechanism," Ernst makes this connection explicit: "digitized signals resemble the tradition of music notation" insofar as "they wait to be algorithmically executed within the CPU."²⁰¹

The *accelerando* of *Space Invaders* illustrates this isomorphism between digital gameplay and the performance of music. When Galloway points out that "[one] plays a game. And the software runs. . . . Here the 'work' is not as solid or integral as in other media," he is preoccupied with differentiating digital games from photography and film.²⁰² In the process, however, he echoes Vladimir Jankélévitch's claim that "music is not made to be spoken of, but for one to *do*: it is not made to be said, but to be 'played.'"²⁰³ Insofar as players' timely input is routed via fingers, thumbs, and other technological devices, digital gameplay has more to do with the choreography of instrumental performance than with spectatorship or discourse.²⁰⁴ Both games and music are better conceived as drastic than gnostic, in Jankélévitch's terms: they are activities to be performed rather than texts to be deciphered. Their unpredictable unfolding in time is a defining characteristic, a paradox that simultaneously distinguishes and problematizes their ontological status. Furthermore, thinking about games musically affords the possibility of coordinating their audiovisual elements into a ludic counterpoint that signifies more than its voices can individually convey.

Music's elusiveness reduced Jankélévitch to a plaintive litany of questions as to where it might ultimately reside: "Is it in the piano, or on the level of the vibrating string? Does it slumber within the score? Or maybe it sleeps in the grooves of the record? Is it to be found at the tip of the conductor's baton?"²⁰⁵ Analogous questions might be asked of the digital game: Does its essence lurk in software, in the binary code etched into optical media or corralled by the logic gates of flash memory? Does it spring into being with the execution of that code, animated by the operational logic that sends it coursing through the console's CPU and audiovisual hardware and modulates it into multisensory stimuli? Or could it be said to emerge at the interface of the game controller with the player's body, distributed across the circuitry of mind, machine, and social network?

Rather than offering categorical answers to these questions, we might observe that all admit—or even invite—a certain ambivalence, a *fort-da* oscillation between affirmatio and demurral that hints at underlying ludic dynamics.²⁰⁶ Music and games may (not) be apprehended as texts, objects, phenomena, and modalities: both forms of activity can be at once rational and irrational, tender and violent, human and inhuman. But digital games differ from music in that their constituent elements are combined and remediated under the technological aegis of the computer, which recursively establishes and enforces the protocols that govern their interaction. In a radical shift from the traditional ontology and aesthetics of mimesis, the computer creates the worlds it represents, realms governed by laws it both reads and writes. In the words of the Atari pioneer Nolan Bushnell, the computer serves simultaneously as "an arbiter, an umpire, a scorekeeper, and a dungeon master."²⁰⁷ Its binary protocols transcode sensible representations of language, number, sound, image, gesture, and affect by way of audiovisual modulations and input devices that operate both as formal mechanisms and as digital interfaces. In this regard, the device that most conspicuously brings the historical, cultural, technological, and epistemological properties of music and digital gameplay into direct contact is the keyboard.

1-4 BITS AND BEATS

If play mediates between the cultural techniques by which human subjects are formed and those that bring the world to hand, then the keyboard is perhaps the paradigmatic instance of a ludic interface. *Negotiating between the epistemological limits of Lessing's juxtapositional and progressive categories, the keyboard and its derivatives materialize and order bits of information, making them available for digital processing by humans and machines.*²⁰⁸ Keys and buttons (re)present bits as spatially discrete entities that are configured and mapped according to specific formations of cultural memory, the elements of which are stored and retrieved by recourse to notes, letters, numbers, tunings, and temperaments. Temporally, the

keyboard enables these bits to be processed in succession, configuring sequences of events that can be programmed (composed), executed in real time (performed), or both at once (improvised).²⁰⁹

Keyboards allow for infinite variation via permutational and combinatorial processes. In true Kantian form, however, this infinitude is only conceivable owing to the imposition of strict limits and an insistence on absolute distinctions. In conjunction with the storage medium of notation, the keyboard represents and implements a set of rules for selection, processing, and transmission that are at once inseparable from and independent of its physical instantiations and cultural functions, plotting the conceptual trajectory of encoding and decipherment delineated in Key 2–2. Most relevant here is the role played by the keyboard as a point of contact between what Patrick Feaster terms “oscillographic” and “melographic” forms of musical inscription, both of which supplement and relativize the technologies of conventional notation.²¹⁰

Édouard-Léon Scott de Martinville’s phonautograms (1853–61) exemplify oscillographic notation, which registers the amplitude of sonic signals.²¹¹ Conversely, melography is closer to traditional music notation inasmuch as it symbolizes information in terms of the contiguous domains of pitch and rhythm, frequency and duration. Whereas pitches are typically iconized by individual notes, accidentals, and their relative positions on the page’s y-axis, however, their rate of temporal succession must be inferred via the decoding of linguistic directives, expressive indications, and arbitrary symbols as well as by the spatial distribution of these signs along the x-axis, which is broadly suggestive rather than explicitly prescriptive. Melography offered an alternative that was isomorphic with the regulated passage of time as well as the keyboard’s topological layout.

The term “melograph” can be traced back to a device designed by the mathematician Leonhard Euler in 1752 that aimed to capture extemporized keyboard playing by attaching pencils to the action of each key that marked pitches and durations on a spool of paper.²¹² As a means of musical programming, storage, and recreation, however, the principle of melography can be extended back to the mechanical flute player described in the ninth century by the three Persian brothers known as the *Banū Mūsā* and forward to today’s MIDI sequencers.²¹³ In 1842, the musicographical reformer V.D. de Stains observed that melographic notation, illustrated in Figure 3 by the Huguenot engineer Salomon de Caus’s design for a hydromechanical organ (1615), plots pitches and durations on a Cartesian grid that allows their relations to be precisely quantified, coordinated, and digitally processed in—and as—space and time.²¹⁴ Owing to their unambiguous calculability, the periodic processes by which pitch and rhythm could be encoded readily lent themselves to the technologies of automation in which Caus specialized: the machine-readable tablature of Striggio’s madrigal “Chi farà fed’al cielo” takes the form of pegs that activate the keys at the bottom of Caus’s illustration.²¹⁵

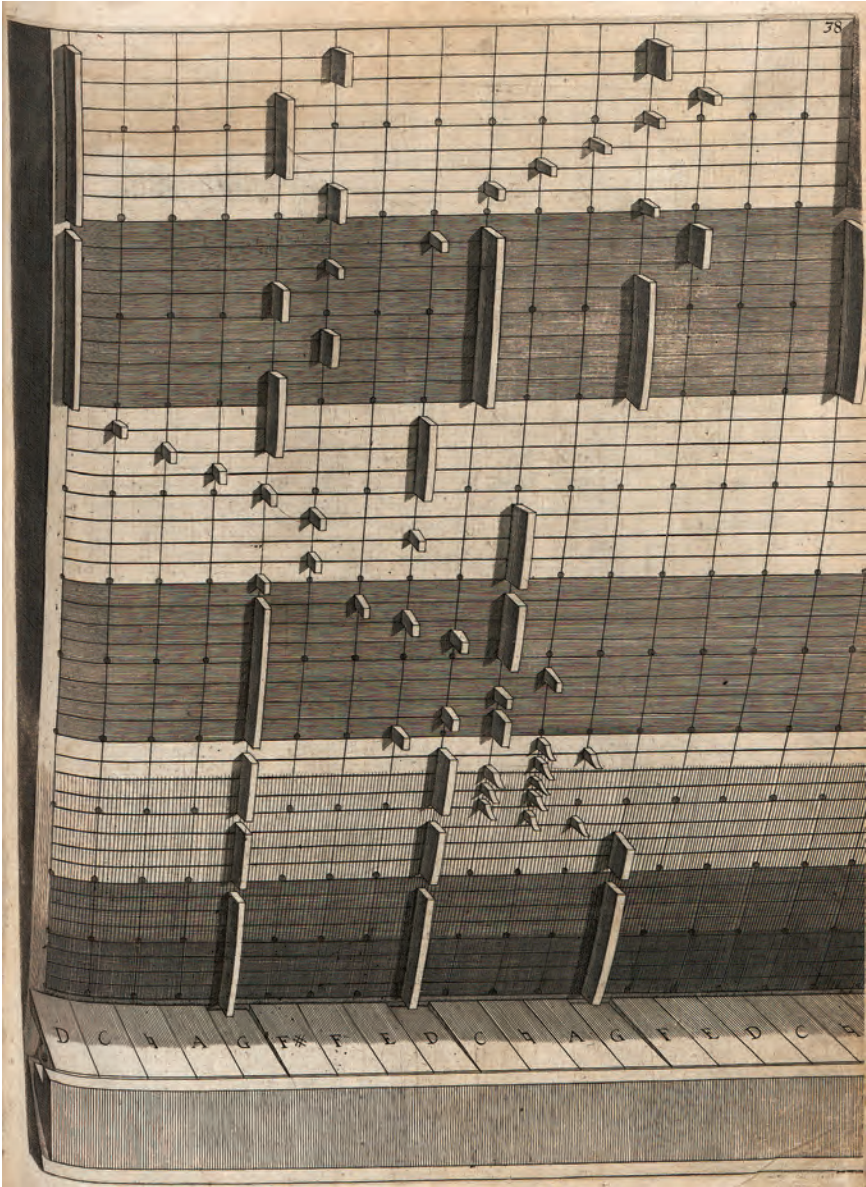
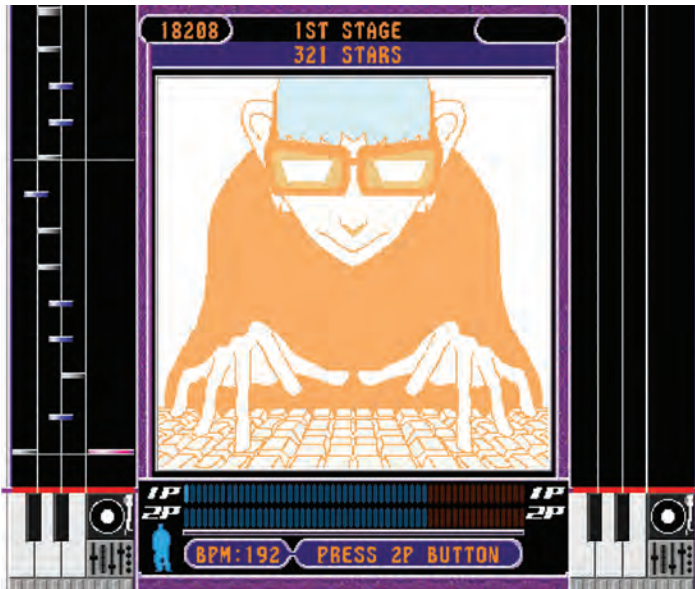
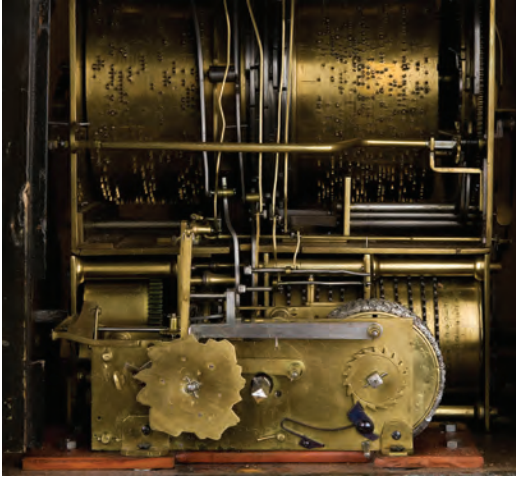


Figure 3. Salomon de Caus, “Abbildung eines musicalischen Steinrads.” Reproduced from *Von gewaltsamen Bewegungen* (Frankfurt: Pacquart, 1615), 1:[83], Universitätsbibliothek Heidelberg (VD17 3:626285D<http://digi.ub.uni-heidelberg.de/diglit/caus1615bd2>). CC BY-SA 3.0.



FIGURES 4 & 5 The studded barrel, humanoid digits, and curved keyboard of *la musicienne*, built by Pierre and Henri-Louis Jaquet-Droz (1774). Photographs reproduced courtesy of the Musée d'art et d'histoire, Neuchâtel, Switzerland.

Figure 6. Screenshot from *beatmania completeMIX 2* (Konami, 2000). Reproduced courtesy of Kurt Kalata and Neil Foster.

As reverse skeuomorphs, and insofar as they constitute discrete units of information that convey presence or absence at a given coordinate, the pegs of Caus's barrel are bits that are stored spatially upon the barrel's cylindrical "memory" and executed in temporal sequence at the keyboard as musical "code." This formulation of the means by which musical data are simultaneously stored on the barrel's surface and made available for digital performance amounts to a rephrasing of Carolyn Abbate's resonant observation that barrels and cylinders occupy a "space within the machine where notation and fingers become one."²¹⁶ In retrieving and reanimating stored information by running it as code, moreover, the recreation of such music demonstrates that "memory locations . . . are just wires turned sideways in time," as noted by W. Daniel Hillis.²¹⁷

Whereas Caus's illustration exposes the mechanisms of automation, constructors of android automata sought to conceal them as artfully as possible. From this perspective, one of the famous android automata built by Pierre and Henri-Louis Jaquet-Droz in the 1770s—a keyboard player known as Marianne or *la musicienne* (Figures 4 and 5)—is particularly telling.²¹⁸ Although Terrance Riley points out that all eighteenth-century automata were "fundamentally musical machines" to the extent that they depended on the pinned barrels and clockwork mechanisms that had long been associated with musical reproduction, the performance of *la musicienne* is unusual in its imbrication of the human, the mechanical, and the musical.²¹⁹ The android's complex engineering coordinates cams that direct the continuous sweep of her forearms (and the rise and fall of her chest) with a studded barrel that does not directly activate sonic production, but rather operates her digits—and digitizes her operations—at the ergonomically curved keyboard. In line with contemporaneous pedagogical treatises, her digital and analog technologies are brought together in the interest of mechanizing human actions as well as humanizing their mechanical counterparts.²²⁰

As Abbate points out, *la musicienne* does not simply reproduce music, but *plays* it.²²¹ In the process, she stages and performs the isomorphic relationship between the keyboard and melographic tablature. At the same time, her doll- and childlike qualities present *la musicienne* as a Gadamerian object of play. Beyond that, her mechanized femininity suggests that the processing of melographic data might do more than provide passive entertainment for human onlookers and listeners: assigning them roles in the digital recreation of music can engage them as players while making them "playable" too.²²²

As historical artifact, digital protocol, and reverse skeuomorph, *la musicienne*'s melographic barrel indexes a wide range of phenomena. Across today's ludomusical landscape, such technologies and their audiovisual properties collide most spectacularly in the rhythm-action genre of digital games, popularized by the *beatmania* (Figures 6 and 9), *Dance Dance Revolution* (1998–2014) *Guitar Hero* (2005–15), and *Rock Band* (2007–16) franchises, which draw directly on the functions represented by



Figure 7. *Donkey Kong Game & Watch* (Nintendo, 1982).
Photograph by Roger Dahl. CC BY-SA 3.0.

la musicienne's digital "memory" and humanoid digits. The "rhythm" and "action" in such games derive from the digital or podial activation of the appropriate keys, buttons, or foot switches in a timely fashion. Programmed by the representation of a rotating studded barrel, the digits of the *beatmania* player activate a keyboard in order to recreate music, just like those of *la musicienne*. In the context of play, such devices become platforms for the exhibition of timing, rhythm, and dexterity, attributes that are as integral to digital games as they are to musical performance.

From Caus's organ to *beatmania*, and whether performed by human or machine, the operation of mechanisms that enable this type of musical recreation requires a consistent source of energy (whether supplied by air, water, solar power, muscles, gravity, or electricity) and temporal regulation (whether imposed by counting, entrainment, clockwork, or crystal oscillators).²²³ This hints at a genealogy that reflects the organ's long-standing associations with musical timepieces. At certain junctures, "mechanical clock" and "mechanical organ" became virtually synonymous insofar as both types of instrument were closely associated with the passing of earthly time, the evocation of eternity, and the marking of festivities.²²⁴ The earliest notable digital games from which evidence of this media-archaeological lineage can be excavated are Nintendo's Game & Watch systems (1980–91, Figure 7), which invite players to test and refine their

abilities to perform sequences of precise audiovisual synchronizations in pursuit of the highest possible score.²²⁵ Both functions of the Game & Watch, the “trivial” game and the “serious” timepiece, are programmed and realized via the pressing of buttons, the oscillation of quartz, and audible feedback.²²⁶ On the one hand, this involves the mechanical simulation of musical time as experienced by humans; on the other, it entails the human emulation of the measurement and partitioning of time by mechanical means. The indiscernible rapidity with which an electronic clock’s liquid crystal display flickers and the slowness with which its numerals succeed one another are both concessions to the normative limits of human perception; conversely, a player’s button presses must be measured and converted into machine code if a difference is to be made within the ludic system. In other words, if coupling is to occur between the operationally closed systems of player and game, the human must become “machine-shaped,” and vice versa.²²⁷

As the anthropomorphic form of *la musicienne* goes to show, absolute distinctions between the human and the mechanical have long been open to question. In *La tonotechnie* (1775), a fastidious treatise on the melographic art of pinning musical cylinders, Marie-Dominique-Joseph Engramelle repeatedly located the elusive quality of “taste” and evidence of a good ear in the microtimings of musical execution, without which music was “cold, mechanistic, insipid, and lifeless.”²²⁸ Conventional notation was incapable of prescribing or capturing these nuances, but they could be accurately rendered via correspondingly subtle processes of calculation, since “nothing in music cannot be exactly measured.”²²⁹ The most refined musical expression was itself expressible by nothing more (or less) than the “measurement of notes by numbers, the division of the circumference of cylinders into so many equal parts as required to apply prongs at precise and regular distances, and the disposition of such prongs in a manner that plays pieces of music with taste and precision.”²³⁰ By enumerating and classifying the fine-grained agogics of a performer’s touch at the keyboard under the rubrics of *tenués*, *tactées*, *silences*, and ornamental *modules*, Engramelle—who numbered clock-makers among his intended readership—laid the claim that musical time was not simply composed of rhythm and meter as conventionally conveyed.²³¹ On the contrary, and on scales ranging from the subtactile *module* to the twenty-four-measure formal span of a minuet, discrete units of time (which, in the case of cylinders, were synonymous with the spatial partitions of circumferential planes) could be transformed into periodic waves and arcing parabolas by way of Engramelle’s musical calculus.²³²

By yoking play to a metronomic clock, digital games such as the Game & Watch stress not only the primacy of ludomusical rhythm, but also what Pias describes in self-consciously Kantian terms as “the game player’s duty.”²³³ In an analogous vein, Nietzsche’s characterization of the “rhythmic tick-tock” of ancient verse as a quasi-sacred “compulsion” that “engenders an unconquerable desire to yield, to join in” suggests how digital gameplay configures a dialectic between *ludus* (the player’s

voluntary submission to the arbitrary and intransigent conditions imposed by the CPU) and *paidia* (represented by the association of games with toys, most clearly conveyed by their simulative functions and miniature scale).²³⁴ Experientially, this dialectic between *ludus* and *paidia* can be construed in terms of Mihály Csikszentmihályi's cybernetic theory of "flow."²³⁵ By presenting a clear goal that becomes increasingly challenging to attain, monitoring progress, and communicating the state of play through a continuous feedback loop, rhythmical gameplay allows the player to navigate between boredom and frustration on the one hand and control and abandonment on the other, ideally leading to an intense state of focus, joy, even rapture.

Konami's *beatmania* series established the blueprint for the performance of rhythm-action gameplay at a keyboard interface (Figure 6). The media-archaeological connection with *la musicienne* is clearly visible, as both illustrated and iconically represented in Figures 4, 5, and 6, but the genealogical ramifications of *beatmania*'s digital interface also extend in other directions. In 1874, Jean-Maurice-Émile Baudot introduced a five-bit chorded interface (Figure 8), configured in the two-plus-three layout of the piano's black keys, as the input device for his multiplexed telegraph system. The conceptual basis for Baudot's five-bit system of alphanumeric encoding had been articulated by John Wilkins in 1641; its optical and acoustical materialization, involving a machine "designed to resemble a piano" and a keyboard "with a minimum of five keys," was first detailed by the keyboardist, composer, and conductor József Chudy in 1787.²³⁶ As Ivan Raykoff notes, Baudot's keyboard was denigrated as unwieldy and inefficient before being rendered obsolete by the automation of its functions.²³⁷ More than a century later, however, the long-defunct keyboard returned, interleaved in black-and-white formation and set alongside the digital simulacrum of an analog turntable, as the interface for *beatmania*'s ludomusical gameplay (Figure 9).

Such latter-day extrusions of Baudot's interface might suggest a chronological narrative based on the ways a communicational protocol was itself communicated.²³⁸ At the same time, it invites us to consider other modes of relating its various iterations to one another, even if—or perhaps especially when—our historicizing instincts are unsettled in the process. Just as Krajewski forges connections between Turing machines and card catalogs, the representational lineage of *beatmania*'s material forms and notational principles can be traced across a broader network, among the nodes of which can be counted not only the MIDI sequencer, the player piano, and Caus's hydromechanical organ, but also the punched cards with which Basile Bouchon, the son of an organ maker, first programmed a textile loom in 1725.²³⁹ These technological artifacts index a protocol by which musical information could be codified and transmitted, revealing the degree to which all music notation is a storage medium that makes information visibly available for audible transcoding. Beyond that, however, the same constellation of objects and principles also represents a clustering of musical and industrial technologies implicated in the epistemology of



Figure 8. Keyboard of Jean-Maurice-Émile Baudot's multiplexed telegraph system (1874). Photograph reproduced courtesy of the Collection Fons Vanden Berghen, Halle, Belgium.

Figure 9. *beatmania* DJ Station Pro controller for Sony's PlayStation console (Konami, 1998). Photograph reproduced courtesy of Takahito Saiki, Kobe Design University.

computation.²⁴⁰ In this regard, the keyboard, notational system, ludic principles, and computational technology that inform *beatmania* simultaneously constitute and represent the game's own media archaeology, encapsulated by Figure 6.²⁴¹

From *beatmania* to *Guitar Hero* and beyond, all iterations of Baudot's five bit interface are digital in the narrow sense: their keys are discrete switches that can convey only the binary states of on or off, 1 or 0. That notwithstanding, their entanglement in cognitive, linguistic, social, and affective systems has enabled them to communicate via encryption, to touch via mechanical processes, to give form to imaginative impulses. Their functions should thus be understood in terms of praxis, "a set of executions or actions in relation to a world," as Galloway puts it in the context of computation, rather than merely in terms of formal ontology.²⁴² Reinterpreting the performance of five-bit telegraphy in parallel and serially as the chords and sequences of musical recreation, rhythm-action games from *beatmania* to *Rock Band 4* demonstrate that the logic governing both systems is chiasmic, reversible, and capable of engaging its players at a tactile and affective level even while ostensibly restricting them to the automatable task of mechanical reproduction.²⁴³ Baudot's telegraph indexed the waveforms of spoken or imagined utterances in symbolic form for the purposes of transmission and storage; conversely, players of *beatmania* convert stored symbols into sound via the same digital operations. In the process, unwieldy transmissive inefficiency is transformed into a pleasurable ludomusical challenge, bearing out Bernard Suits's definition of playing a game as "the voluntary attempt to overcome unnecessary obstacles."²⁴⁴

The ludomusical dimensions of Baudot's interface as realized by *beatmania* reveal ways in which communicative technologies can become playful when put into digital practice, embodied by "the nimble and orderly movements of the fingers."²⁴⁵ But the original function of Baudot's device—to make present a trace of that which is physically absent—remains. Accordingly, the performance of communicative techniques can connect subjects and objects across time as well as space, mediating between past and present in the course of bringing remote phenomena into contact.

1–5 PLAYING UNDEAD

Materialized via binary formalism, enabled and constrained by game-theoretical dynamics, and driven by cybernetic feedback loops, the praxis of digital game-play reflects the culturally embedded precepts that underpin the von Neumann architecture as well as the psychological and affective impact of its operations. In Nietzschean terms, the digital game's Dionysian excesses and its mythic, otherworldly qualities follow, quite logically, from the Apollonian rationality that determines the course of proceedings: its *paidia* and *ludus* are entwined.²⁴⁶ *Games render rationality palpable: their significance derives from a vast array of visual, sonic, tactile, and affective representations that issue from the spatiotemporal*

*modulation of digital operations.*²⁴⁷ In the terms of *mimicry*, these modulations can be perceived as analogous as well as simulative in that they index the distance between a concept, object, or praxis and its representations, testifying to the ubiquitous truth of technological deception.

Digital games such as *beatmania*, *Guitar Hero*, and *Rock Band* that take musical recreation as their primary subject matter form only a small subset of titles that might be considered ludomusical. From the *Tron*-like technoscapes of *Rez* (2001) to the musical ramifications of the narrative binary trees presented by *L.A. Noire* (2011) via the platforming hijinks of the bongo-controlled *Donkey Kong Jungle Beat* (2004), games distribute the responsibility of ludomusical enactment in innumerable ways across the nexus linking composers, developers, hardware, code, interfaces, and players.²⁴⁸ In the present context, and for reasons that extend beyond its thematic and mechanical foundations, the relatively obscure *Frederic: The Resurrection of Music* (2011–14Figure 10), developed by the Polish studio Forever Entertainment, provides the most striking combination of the ludomusical tropes introduced thus far.

Cutting across the registral divide separating the elitism ascribed to “classical” music from the putative philistinism of digital games, the liminal figure of Chopin has formed an unexpectedly persistent locus of ludomusical encounters that unfold at keyboards, whether they involve the relaying of single bits of information, the activation of complex acoustic events, the realization of the ineffable, or all of the above. His music reveals how the play of fingers over the keyboard allows for the creation of sonorous effects that simultaneously reinforce and defy its black-and-white gridding of frequency. In 1852, for instance, the exiled German composer, author, and pedagogue Johanna Kinkel heard Chopin’s piano music to herald the “emancipation of quarter tones” by “rattling the gate” that both barred and disclosed “Nature’s eternal sounds.”²⁴⁹ Condemned to “slink reluctantly by way of semitones,” Chopin’s melodies “grope for finer spiritual nuances than current intentions can realize.”²⁵⁰

Kinkel’s dissatisfaction was framed as both symptom and diagnosis of the piano’s crude temperamental partitions, but its ramifications extend deeper, infiltrating the foundations of the keyboard’s digital epistemology. Thinking of such interfaces not merely in terms of the work accomplished, or the information transmitted thereby, but as facilitators of play opens up different genealogical perspectives, however. Like the narrow voids at the intersections of paving stones, the cracks between the piano’s keys present ludomusical challenges, successful navigation of which entails both acknowledgment and circumvention. On the one hand, the keyboard’s crude partitions could be heard to distort natural continua; on the other, as Siegert describes the latticed “veil” through which Alberti rendered natural phenomena as veristic images, its gridwork formed frames through which Chopin’s swooping curves could become observable, calculable, graspable, and recreatable in a lifelike manner.²⁵¹

From Kinkel’s day to our own, the keyboard has consistently mediated Romantic fantasies that at once admit and deny the mechanisms that bring them to life.²⁵²



Figure 10. Screenshot from *Frederic: The Resurrection of Musi* (Forever Entertainment, 2011–14). Reproduced courtesy of Forever Entertainment SA.



Figure 11. Screenshot from *Eternal Sonata* (Bandai Namco, 2007–2008). ® and © Bandai Namco Entertainment Inc. Reproduced courtesy of Bandai Namco Entertainment America Inc.

An analogous logic obtains in relation to the temporal dimensions of digital play. Whether taking the form of the microtimed desynchronization of melody and accompaniment in a Chopin nocturne, the improvisation of a Hammond organ

solo, the expert playing of *Guitar Hero*, the dexterous transmission of an urgent text message, or the destruction of an enemy base, such play is predicated on *kairos* rather than *chronos*, on strategically seizing the right moments to syncopate the metronomic spacing of the matrix that partitions milliseconds and centuries alike.²⁵³

Chopin reportedly bestowed the title “valse du petit chien” on his Waltz in D flat op. 64, no. 1, after being amused by the *ilinx* of a small dog chasing its tail.²⁵⁴ While the waltz’s subsequent reception history might have been predicated on an accentual misplacement (the adjective “minute” was first applied as a simple diminutive), the fact that so many pianists have responded to the challenge of completing a performance within sixty seconds testifies to its ludic qualities.²⁵⁵ Such recreations of Chopin’s music cannot be understood in terms of mimesis, and still less within the normative rhetoric of performance practice, but they make explicit the scope—which is also to say the limits—of simulation as a fictive mode of play. On the one hand, an emphasis on speed might seem to reduce the waltz to a mere pretext for the display of mechanistic virtuosity; on the other, it need not preclude the imaginative demonstration of qualities more typically associated with the performance of Chopin’s music.²⁵⁶

This quickly becomes evident from a perusal of speedruns of digital games, in which players also aim for completion in the shortest possible time under regulated conditions that either prohibit or mandate the availability of technical assistance from software or hardware tools. In the former case, phenomenal dexterity is a prerequisite for the accomplishment of such feats, but the most impressive performances of both types rely less on mechanical proficiency and more on an intimate knowledge of the logic on which the game’s mechanics are based. The acquisition of such skills and knowledge requires creativity, acuity, and sensitivity as well as painstaking practice.

As in *Guitar Hero* and countless other rhythm-action games, the outcomes of *Frederic*’s gameplay are calculated according to the speed and accuracy with which players can “match” the notes that, like the pegs on Caus’s rotating barrel, travel toward the piano keyboard at the bottom of the screen (which, on the PC and Macintosh versions of the game, is mapped onto its QWERTY counterpart). For Adorno, the code of the barrel organ’s cylinders (“die Geheimschrift der Walzen”) enabled the seizure of all “unclaimed musical goods” from both past and present, whether sacred or profane, comic or tragic; as a result, they were flattened, rationalized, commodified, alienated, and rendered “prehistoric” by its technological “magic.”²⁵⁷ From Caus to *Frederic*, an isomorphism persists across devices and technologies that involve the transduction of such code—whether it takes the form of staff notation, tablature, real or virtual pinned barrels, MIDI data, or C++—via mechanisms of play enacted by humans and machines.

While its subject matter might be relatively unusual, *Frederic* is thus a typical digital game insofar as it unabashedly remediates its narrative, visual, and mechanical elements—not to mention its soundtrack. *Frederic* presents nine “catchy remixes”

of Chopin's greatest hits in the form of "epic musical duels" between Chopin—who, according to the game's promotional materials, has returned from the dead to "save the world from soulless, mass-produced music"—and stereotypical representatives of the various popular genres in which his music has been remixed, mashed up, and mercilessly quantized for the sake of digital synchrony. Ludicrous though it may seem, *Frederic's* premise is typical of its genre: many rhythm-action games launch the player on a quasi-Pythagorean quest to restore harmony and order to a world under attack from alien forces whose hostility can be gauged in terms of dissonance (and vice versa).²⁵⁸ In this regard, *Frederic's* violent imagery is directly extrapolated from the nineteenth-century piano duel and its agonistic genealogy: like Apollo vs. Marsyas, it represents a musical game of life and death.

Needless to say, irony abounds in *Frederic's* lambasting of "soulless, mass-produced music" and its shameless caricature of Romantic ideals concerning genius, sensitivity, and performance, a genealogy of which is mapped out in Key 2–3. Even here, however, strange symmetries and resonances emerge between Chopin's limning of death both as a historical figure and in his digital afterlives.²⁵⁹ In Giorgio Agamben's terms, the objects and referents of play constitute "an utopian topology of historyland, which has no site except in a signifying difference between diachrony and synchrony, between *aiōn* and *chronos*, between living and dead, between nature and culture."²⁶⁰ The plot of *Eternal Sonata* (2007–09, Figure 11), a sensorially opulent role-playing game, unfolds within the composer's tubercular fantasies as he lies on his death bed; conversely, the monochrome figure of *Frederic* represents Chopin on the other side of the threshold separating life from death, inhabiting the realm of the "undead" populated by ghouls, zombies, and other denizens of digital game-worlds.²⁶¹ As productions of Chopin's consumption, *Frederic* and *Eternal Sonata* represent the senses in which music and play unfold beyond the limits of history's temporal flow and yet bear haunting traces not only of beauty, but also of conflict, entropy, death, and decay.

With the keyboards of *la musicienne*, Baudot, *beatmania*, and *Frederic* in mind, and thus attuned to the temporal transformations that media technologies effect as well as undergo, we might detect the objections of musical objects to the uncritical application of biographical or historical narrative as a means of describing their passage through—and creation of—time.²⁶² The chronological ordering of such phenomena is, in Ernst's words, "less about temporal antecedence than about the techno-epistemological configurations underlying the discursive surface."²⁶³ In ludomusical terms, we might go further: while these technologies materialize particular epistemological strands and afford specific types of behavior, they are interwoven with others that reflect distinct aspects of both music and play.

Digital games instrumentalize a form of play predicated on the miniaturization of objects as toys and the concomitant flattening of the past into a single frame of reference, animated and yet bound by the in(de)nitely iterative cycles of the

CPU's clock. But these tendencies are already apparent in the musical technology of Caus's barrel. For a grotto in the famous *hortus palatinus* at Heidelberg Castle, Caus designed an elaborate mechanical staging of Apollo's contest with Pan (Figure 12), in which the contrasting instrumental means by which each god performs covertly share the same digital and cylindrical mode of programming.²⁶⁴ This foreshadows Adorno's observation that the demotic technology of the barrel organ is associated with the injection of the banal into the holy: whether its music is heard to issue from god, man, or beast, and whether its (re)creation relies on the sonic activation of pipe or string, the barrel remains sublimely indifferent to the provenance and functions of the information that its rotation processes.²⁶⁵

Perhaps even more telling is Adorno's construal of the relationship between a barrel organ and its mighty Baroque counterpart as analogous to that between a "puppet show and a tragedy."²⁶⁶ For Caus's contemporary Markus Sittikus von Hohenems, archbishop of Salzburg and tenant of the Hellbrunn Palace, Marsyas's tragic end became an automated puppet show by way of the techniques of mechanization described and illustrated by Caus.²⁶⁷ Reenacting the scene rhetorically conjured by Philostratus the Younger, Sittikus's knife-wielding Apollo and tree-bound Marsyas endlessly rehearse and replay the harrowing moments preceding the latter's execution (Figure 13 and Video 1)²⁶⁸ Hovering between life and death in mimetic as well as narrative terms, their repetitive motions animate Apollo's divine power and Marsyas's desperate protestations by harnessing inanimate forces.

Despite its Promethean pathos, however, the scene is undercut by the very technological means that produce it. Mechanized and miniaturized, Apollo and Marsyas are turned into playthings that, like Chopin in *Frederic* and *Eternal Sonata*, are neither alive nor defunct but rather undead. Like a short-circuiting digital game or an animated GIF, they are trapped in an infinite loop and thereby suspended from historical time. For Agamben, the paradoxical effect of such dehistoricization is to render history all the more vivid: the toy "makes present and renders tangible human temporality to itself, the pure differential margin between the 'once' and the 'no longer.'"²⁶⁹ The value of relating *Frederic* and *Eternal Sonata* to Chopin lies within this differential margin, which can also be measured by the keyboard as a techno-epistemological configuration capable of synchronizing the desynchrony between the present and the past. Regardless of its avowed historical orientation, any performance of Chopin's music performs an analogous act of (de)synchronization.

Accordingly, the mode of play also allows us to project the differential margin between the "now" and the "yet to be." In "Chamber Music," a speculative essay written in the 1980s, Vilém Flusser imagined playful praxis at keyboards to encapsulate the archetypal mode of interaction in what he foresaw as the interconnected, "telematic" society of the future.



Figure 12. Caus, “Abriss der Höhlen oder Grotten dess Imoli.” Reproduced from *Von gewaltsamen Bewegungen*, 2:15, Universitätsbibliothek Heidelberg(VD17 3:626285D)<http://digi.ub.uni-heidelberg.de/diglit/caus1615bd2>. CC BY-SA 3.0.

Figure 13. Hydromechanical automata representing Apollo and Marsyas, commissioned by Markus Sittikus von Hohenems for the Hellbrunn Palace (1618–19). Photograph by Matthias Kabel. CC BY-SA 3.0.

Video 1. Excerpt from “Apollo & Marsyas: Hochmut vor dem Fall” ([youtube.com/watch?v=jtrM8sfUJmc](https://www.youtube.com/watch?v=jtrM8sfUJmc)), featuring the automata shown in Figure 13. Narrated by Cay Bubendorfer. Music by Leo Ferner/Agentur Orpheus. Written and directed by Karl Schupfer. Filmed and edited by Johannes Killer. Reproduced courtesy of the Information Center of the City of Salzburg.



To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.1525/luminos.16.1>

People will sit in separate cells, playing with their fingertips on keyboards. . . . The prevailing state of mind will be reminiscent of the one we experience in our creative moments, the experience of being out of oneself, of adventure, of orgasm. . . . The basis for such music-making is an original score, a program, a set of rules. . . . I imagine these musicians meeting not to read scores but to improvise from available scores, as was common in the Renaissance. . . . [But such scores] will soon disappear behind the horizon of musicians who are improvising with continually reprogrammed memories. . . . The recording device is nothing like the work of chamber music (the result of the work); rather it serves as its memory, which is durable and can be randomly replayed. . . . Chamber music is pure play, by and for the players, for whom listeners are superfluous and intrusive. It employs participation (strategy) rather than observation (theory). . . . It is futile to look for the meaning of the information that emerges in this way anywhere but in the game itself, in the players and the rules they follow.²⁷⁰

Within the confines of this brief thought experiment, Flusser combined and compressed the introversive significance and rule-bound premises on which Kantian play depends, a Gadamerian acknowledgment of play's chiasmic motion, Csík-szentmihályi's immersion in the intense pleasure and excitement of ludomusical experience, Foucault's genealogical sensibility, a Nietzschean consciousness of play's ever-emergent nature, and recognition that the generative powers of memory and recording are recreative as well as reproductive.

In certain ways, Flusser's prophecy of the "chamber music" to come also recapitulated Adorno's bleakly elegiac chapter on the same topic in his *Einleitung in die Musiksoziologie*. Like Flusser, Adorno stressed the interaction of players over the passivity of listeners, invoking the Kantian function of functionlessness in describing "a production process without an end product. . . . In a double sense, the players are merely playing."²⁷¹ Although Adorno acknowledged the agonistic elements of chamber music, its ludic give-and-take was subsumed under the ideal of "fair play [as] in the old English sports," ultimately "anticipating a state in which labor becomes play."²⁷² As it transpired, however, the reverse happened: in music as in sport, the noble amateurism of play was either professionalized or relegated to the nonproductive margins of bourgeois life.²⁷³ In the process, its autotelism was coopted by the pressing demands of both work and leisure, and the primary connotation of "amateurism" slid from ardent love to rank incompetence.

While Adorno's gloomy prognostications might have been overdetermined by historical consciousness, its patina has also dulled the gleam of Flusser's imagined future. For the moment, we can choose to focus instead on responding to the playability of the music that surrounds us today, whether conceived as a reconstruction of a prior event, as a simulation of praxis under a particular set of historical conditions, or as a simulacrum bearing no particular relation to the past. From a ludomusicological perspective, all these forms of play forge connections that enable us to historicize the new and to renovate the old via

techniques of projection and retrojection. These techniques should be understood as supplementary rather than self-sufficient—they can neither supersede historical investigation nor obviate its attendant responsibilities. But by interrogating the qualia of historical events and attempting to reconstruct their ludomusical logic, they offer the tantalizing prospect—however elusive, illusive, or delusive it may turn out to be—of bringing the future of the past within range of twenty-first-century sensoria

Digital Analogies

From the clavichord to the Moog synthesizer and far beyond, the keyboard has established conditions under which ludomusical behavior can emerge. Whether instantiated as an ordering principle, cognitive schema, or material interface, it provides a platform on which musical motives, gestures, propositions, and ripostes can be put into play. But in what terms can these conditions and the unfolding of such play be described? At the most literal level, addressing this question entails examining the relationship between keyboard and gameboard, conceiving of both as fields of tactical calculation and action: as we shall see, a thread of historical evidence bears this analogy out. More broadly, it involves thinking archaeologically with the notion of the keyboard as an interface that has operated across a range of media systems. This approach is not primarily concerned with the content and interpretation of specific musical signs or signals, taking as a given that these vary widely in accordance with shifting historical, cultural, organological, and repertorial parameters. Rather, it focuses on the keyboard's rules of engagement and codes of conduct, reflecting functions of mediation that operate both analogically, by translating mechanical input into corresponding sonic consequences, and digitally, insofar as such input is typically initiated by the play of figures as discrete entities.¹

*Across its multifarious instantiations, the keyboard negotiates between the digital and the analog to the extent that via digital operations of selection and activation, input and output enter into an analogical relation.*² Accounting for these maneuvers entails both the acknowledgment of difference and the recognition of the isomorphism evinced by diverse ludomusical phenomena. To these ends, ludomusical formations can be identified as, and by way of, a constellation of *digital analogies*.

As its name suggests, a digital analogy seeks to relate its constituent elements in ways that simultaneously register and resist binary oppositions. Correspondingly, this Key frames relations between “music” and “technology” by seeking to unlock not the impact of one on the other, but rather the ways in which technologies can be understood as always already musical—and vice versa.

The terms “digital” and “analog” have long and complex histories. While the oldest meanings of the classical Latin *digitus* refer to the finger, it can also signify a finger’s breadth, thereby indexing both the body’s presence and its trace.³ (This ambiguity is evinced by the archaic use of “digitals” to refer to keys on an instrument, objects designed to accommodate fingers.)⁴ Plautus, Cicero, Ovid, Pliny the Elder, and Quintilian all associated fingers with counting, reckoning, and computation, and by the twelfth century *digitus* had autologically come to denote a decimal number.⁵ Procedures of calculation involving binary and duodecimal operations had also been made imaginable by hands and fingers, going to show that “counting is older than numbers,” as Macho puts it.⁶ What we understand by the digital, from the principles of discretely dividing and partitioning the world to the manipulation and combination of the elements thus derived, both issues from and takes the form of embodied knowledge.⁷ Digits embody processes of enumeration while enumerating embodied experience: we were digital *avant le chiffre*.⁸

If digits indicate how the apprehension, tallying, and manipulation of objects inform their mental ordering and classification, then a corresponding claim can be lodged with regard to the ancient Greek ἀνάλογος (*analogos*), which has to do with the derivation of proportional relations between objects and phenomena from sensory perception rather than from abstract or rational thought.⁹ Analog modes trace continuity, materially delineated by vector, contour, or waveform; at the same time, like metaphors, they span and measure the gap that separates the resembled from the resembling. They thus represent both continuity within a medium and the rupture of transduction, of technical and imaginary transfer between senses and media.

Digital and analog modes also frame diverse forms of play. The indexical relation between finger and number is rendered ludic in the ancient multiplayer game of *morra* and the competitive game known as chopsticks.¹⁰ More fundamentally and elaborately, the rules governing all formally regulated games of competition and chance can be rendered as mathematical formulae, as von Neumann and Morgenstern demonstrated in their *Theory of Games and Economic Behavior*. According to von Neumann’s minimax theorem, optimal strategies of such play are also calculable.¹¹ Game theory thus provided the mathematical framework that underwrites the technological processing of the rules and gameplay of all modern digital games, which still run on the computational architecture that bears von Neumann’s name.

Conversely, analogies describe the playful means by which one person or object represents or simulates another. Analogical maneuvers thus animate multifarious forms of role-play integral to *mimicry*, ranging from children's games of make-believe to massively multiplayer online role-playing games.¹² While analogies can operate by imaginative and rhetorical means and need not adhere to the rational inference of resemblances, they are often overlaid on formal game systems in order to humanize—or divinize—their abstract logic. In Comanini's *Il figino* (1591), for instance, the classes and ranks of chess pieces are directly mapped onto the attributes of generals, archers, cavalry, and phalanxes of infantry; more figuratively, the sweeping motions of the queen analogize the vectors of good fortune that direct events on the battlefield, her imperious power uniting forces that would otherwise remain shapeless and dispersed.¹³

Today, certain aspects of the meanings of “digital” and “analog” have eclipsed many of their other historical connotations. Beyond routine semantic drift the impetus for these shifts can be inferred from a sequence of technological developments. Over the latter decades of the twentieth century, the digital and the analog served as lightning rods for debates concerning “the practical processes by which the world was represented in machines and by which those representations were made effective in the world,” as David Mindell puts it.¹⁴ According to this narrative, the relentless march of technology fused the digital and the analog into a mutually constitutive dyad. Digitality became a far-reaching principle governing the rational operations of distinguishing, ordering, and calculating, while the analog assumed the role of the digital's “other,” serving as complement, antithesis, outmoded paradigm, or bastion of resistance. The problem, as McKenzie Wark points out, is that distinguishing between the analog and the digital in this way involves the recognition of a “clear distinction” rather than a “slippery difference,” which is to say that it relies on a marked binarism that itself articulates and enforces digital logic.¹⁵ As Anthony Wilden observes, such formulations suggest that “without the digital, we could not speak of the analog.”¹⁶ Aden Evens exposes the same problem when contrasting the sterile formalism of digital partitioning with what he asserts to be the “ontological fuzziness inherent to actuality itself.”¹⁷ Arguing that digitality can offer only a pixelated and quantized rendering of the world, Evens implies that the infinite gradations of the analog somehow describe it *wie es eigentlich ist*.¹⁸ But this contention itself imposes a binary choice between the digital and the analog, dividing them along the line of thought that separates the production of cultural differences from the morass of nature's raw materials.¹⁹

While acknowledging our digital predicament as an acute symptom of modernity, Flusser addressed it from the opposite angle by drawing attention to its ancient lineage. In the essay “Why Do Typewriters Go ‘Click?’” posthumously published in 1993, he provided first a heuristic answer (because digital clicking

“is more easily mechanized” than analog sliding), and then an ontological one: because, as Democritus asserted long ago,

everything there is in the world (and the whole world itself) stutters. . . . Everything quantizes. Thus numbers, but not letters, correspond to the world. It is open to calculation but not to description. . . . Letters (if they want to survive) have to simulate numbers. This is why typewriters go “click.”²⁰

Flusser proceeded to consider whether the quantization of the world via atomic theory, calculus, or quantum theory accounts for its workings or merely corresponds to them. Does our perception of vectors and signals simply reflect the ways our senses transform quanta into continuously variable qualia, bending and warping the world after our own likeness? Or, as Evens suggests, is quantization itself the externalization of embodied digitality, a human bitmapping of the world that makes it enumerable by brains and machines?

Caught between these seemingly unanswerable questions, we find ourselves bound once more by the binary logic of either-or. Thinking in terms of digital analogies, however, we might apprehend digitality by sliding it along a continuum that registers its metaphorical, musical, and mathematical meanings, which will in turn reveal how digital processes can elucidate the techniques by which analogies are materialized, embodied, and collated.²¹ As both natural phenomena and agents of cultural forces, human digits confound distinctions made between the figures of culture and the ground of nature even as they embody and perform them. In this sense, figures are instrumental to the acquisition and deployment of cultural techniques, which both predate and recursively process such distinctions.²²

From the “wiry concord” of the Dark Lady’s virginals to the click of Flusser’s typewriter, the outcomes of play at the keyboard reflect and reveal the conditions of its sociotechnical channels. En route from finger to ear, the signals of keyboard play are liable to be distorted and transformed by encounters with noise, ranging from analog wow and flutter to digital jitter and aliasing artifacts. The keyboard thus has much to contribute to our understanding of digitality and analogicity as both contemporary and archaeological formations, while the concept of the digital analogy offers a reciprocal means of articulating the channels, operations, and techniques associated with the keyboard.

The interface of the keyboard can be approached as a zone where the digital and the analog come together under the rubric of play. From the most basic MIDI controller to the *ondes Martenot*, digital interfaces have typically been supplemented by analog modulators, whether they take the form of a pitch-bend wheel, swell pedal, ring, or ribbon controller. Digital play freely oscillates at the keyboard, limited only by the analogical extents to which its patterns can be realized or imagined. Likewise, analog play is subject only to the constraints of the digits that embody and enumerate it. Of particular significance is the keyboard’s capacity to represent letters and numbers as well as notes, thereby facilitating correspondences

between literate scripts, algorithmic procedures, and sonic outcomes that are at once digital and analogical. The keyboard's regulation of these literary, mathematical, and musical realms has inculcated a diverse array of cultural techniques with which to play (and, on occasion, to challenge the prevailing social and political rules). Via its operations in concert with human bodies, and as analog, complement, and supplement to the digital logic of fingers, the keyboard is thus implicated in the performance not only of notes, numbers, and letters, but also of violence, gender, and (dis)ability.

Instead of taking the form of a linear history or the circumscription of a delimited area, this *Key* performs five sweeps across different registers of the keyboard, each attuned to a particular bandwidth of ludomusical resonance. The first addresses the keyboard's prehistory as well as the analogical and digital terms in which it has been engaged. Revisiting Apollo's mythical contest with Marsyas as its point of departure, it considers the sublimated violence of musical play as well as various means of tallying and settling scores that extend from the realm of Greek mythology to today's digital games. The second is concerned with the keyboard's materialization of notational concepts and its transcoding of letters, numbers, and pitches, focusing on the rendering and inscription of sound in the terms of both *technē* and *logos*. The third examines the keyboard as an interface at which subjects have been cultivated via the acquisition and demonstration of techniques associated with communicative media, while the fourth explores how keyboards constitute both material and analogical fields of play. Finally, after documenting ways in which the playing of various keyboard instruments has been invested with recursive properties, the fifth considers how two recent sonic art installations have invoked digital and analog modes of automated ludomusical behavior that recreate sounds heard or imagined in the past. Cumulatively, these five passes over the keyboard's ludomusical terrain draw attention to the playful procedures by which music has been devised, performed, and recreated there. They amount to an effort to conceive of these acts not primarily in terms of textual transmission or interpretation, but in light of the ideological and material conditions that have given rise to them.

When excavating the remnants of ludomusical play, we encounter keyboard interfaces at which digital concepts were materialized and embodied prior to their memorialization and abstraction. Historical modes of inquiry also expose our own relationships with the past to be analogical insofar as they rely on correspondences between objects and actions that echo, trace, or stand in for one another. If techniques of mediation can be parsed as functions or symptoms of historical processes, however, the disciplinary vectors of media archaeology reverse the proposition by asking how media make the recounting of history possible. From the four-handed *fort-da* of "L'escarpolette" from Bizet's *Jeux d'enfants* to the dexterous permutations of digital game players at their PCs, ludomusical behavior at the keyboard can be understood in terms of its formal constraints, its material

grain, its transmissive tactics, and its phenomenal pleasure.²³ As Ernst suggests, this invites us to rethink linear models of temporality in order to acknowledge the spiraling and shuffling of analog and digital media, which offer ways of recognizing the differences and similarities between the keyboard's diverse manifestations that go beyond the chronological and alphabetical seriation of historical narrative.²⁴

At the same time, the long view of media archaeology cautions against the reification of technology by revealing that even the most solid and stable configurations merely slow the rate at which change flows.²⁵ There was musical life before the keyboard as we know it, just as there will come a time when the conditions that have sustained it no longer obtain. Even as they document the passage of time, moreover, media are themselves subjected to it. Musical media make this particularly clear: testifying to both durability and entropy, the historicity of instruments that capture and (re)produce sound enables them to operate as the kind of medium that connects the living and the dead. By "pass[ing] on to the senses of others what would otherwise fade away," in Kittler's words, keyboards and their associated technologies allow us to play *back*, to construe musical recreation as reenactment as well as praxis in the present.²⁶ In this sense, and in relation to both recordings and instruments, play is no less than the means by which music's evanescence perdures.

2-1 APOLLO 1, MARSYAS 0

To excavate the oldest media-archaeological evidence for digital and analogical musical performance, we must return to a mythical realm that lies beyond the reach of historical investigation. In this context, the etymological history of the Latin *digitus* is itself telling inasmuch as it points in two irreconcilable yet complementary directions. On the one hand, as Evens points out, its roots might lie in the Greek δεικνυμι (*deiknumi*, "to show"), associated with the word *deixis* and thus with the finger that indicates *this*, not that; on the other, they may be traced back to the term δέχομαι (*dechomai*), meaning to grasp or receive (just as "finger" derives from *fangen*, "to catch"), thus implying accommodation rather than discrimination.²⁷ The related term δάκτυλος (*daktylos*) takes its autological name from the relation between the three bones in each finger, illustrating how the ordering and measuring of music and poetry were accomplished via the use of the body to register and tally external phenomena as well as by the assertive extension of pointing fingers and stamping feet.

Throughout ancient Greece, acts of embodied enumeration were often performed in Apollo's name. In the context of hexameter's legendary origins in Apollonian divination as mediated by the Delphic oracle and her priests, Kittler echoed Nietzsche in observing that poets and their texts "participate in the bloody task

of making bodies hear and obey. Verses provide an instrument that fixes speech mnemotechnically, steers bodies rhythmically, and guards against disturbances in channels of discourse.²⁸ The dactylic hexameter of Callimachus's *Hymn to Apollo* conflates the divine foot with which Apollo kicked Phthonos (the personification of envy), who had the temerity to criticize the orderly attributes of the paean that the hymn enacts, with the metrical foot of poetry itself.²⁹ With kithara in hand, moreover, Apollo could infiltrate and order the imagination as well as the body. The Roman elegist Lygdamus dreamed of a visitation from the god, whose digits grasped an ivory plectrum that enabled them to "speak" alongside his sonorous voice.³⁰ For Lygdamus, the kithara was closely associated with the lyrical (and digital) qualities of discernment and discrimination, with bittersweet refinement rather than booming resonance.³¹ Lygdamus's dream also reveals how the logic of selection informed and ordered instrumental performance: during even the most fleeting strumming, Apollo's plectrum was deployed to pluck *that* string at *this* moment, not any other.³²

But Apollo's kithara also represented the plotting of analogies, of systematic research into correspondences between musical and cosmological order. This line of interpretation can be traced back to Aristides Quintilianus, who pursued it to justify Apollo's triumph over Marsyas.³³ For Aristides, the kithara's strings analogized the soul of the universe, while the breath animating the aulos was associated with the sublunary realm: Apollo's victory thus bore out the superiority of the celestial over the mundane.³⁴ Following Pythagoras, however, Aristides also contended that music, human bodies, and divine souls all resonated in sympathy by virtue of such mimesis, since they all demonstrated the *harmonia* of numerical relations.³⁵ Mathematics could correlate the abstract and the tangible: through music, the analogies of *harmonia* were made audible.

In this vein, Albright observed that the mechanism by which Apollonian analogies were realized was digital: "music [was] conceived as sounding numbers, numbers that can easily be transferred to any other medium."³⁶ Echoing Flusser, Albright thus identified the formal fungibility of numbers as elemental to the digital paradigm of universal translatability that enables information to travel freely across all manner of media.³⁷ In the modern era, such digital transcoding owes an obvious epistemological debt to Leibniz's concepts of a *characteristica universalis* and an *alphabetum cogitationum humanarum*, which could be indexed by musical notes as well as other sets of discrete symbols.³⁸ But for Kittler, it was ultimately attributable to the ancient Greek alphabet, the first system capable of representing not only letter and number, but also musical tones and ratios, thereby enabling the construal of relationships that were demonstrable by kitharedic and auletic performance.³⁹ Channeling the Pythagorean spirit of Hippasus, Philolaus, and Archytas, Kittler described the lyre as a magical *Spiegelzeug* ("plaything") that "connects mathematics to the domain of the senses," instrumentalizing the analogies of *harmonia*.⁴⁰

Marsyas's transformations into a river, wineskin, windbag, or drum reveal how the powers of analogy could enable some part of him to withstand death, both despite and owing to Apollo's savagery.⁴¹ Correspondingly, his music was itself analog to the extent that it was rendered and described as continuous rather than discrete, consisting of "wind, breath, *pneuma*—animating spirit, feeling made sound," as Albright expressed it.⁴² As an instrument activated by a more or less continuous column of air, the aulos did not conform to Pythagorean logic: its elemental unit (or monad) was neither a ratio nor a definably discrete quantity, but rather the *diesis*, an indefinitely small interval etymologically linked to the unpredictable and unquantifiable leakage of air from the finger holes.⁴³ Despite the involvement of digits, as noted by Ovid, Marsyas's overblown musical play thus defied quantization, which helps explain why the Muses initially had difficulty evaluating his performance in relation to Apollo's.⁴⁴ In the face of their indecision, Apollo had to resort either to the performance of an instrumental inversion or to the addition of his voice to his kithara: since both techniques were unavailable to Marsyas, the god's victory was declared by fiat.

Was this triumph a case of *adynaton* (the divine demonstration of the impossible), the outcome of a cunning ruse, or the prospering of a cheat? Beyond the issue of instrumental prowess, the question's undecidability hints at the magical deceptions wrought by the machinations of media technology. Writing of the lament performed by Orpheus and Echo in Monteverdi's *L'Orfeo*, in which the latter reproduces fragments of the former's utterances, Klaus Theweleit spins the issue around this technological axis: "you may laugh, but ... Orpheus is asking for Edison."⁴⁵ When it came to singing and blowing simultaneously, Marsyas would have needed to wait a little longer for the invention of multitrack recording.⁴⁶ Ultimately, however, it is not so much Apollo's reliance on media effects to bend the rules of play that arouses disquiet, but rather the gulf that yawns between the contest's ludic conduct and its gory aftermath. According to Ovid, this discrepancy shocked Marsyas himself, who realized too late that "[a] pipe's not worth the price!"⁴⁷ How can Marsyas's agony be justified as a function of Apollo's whimsy?

While there seems to be no inherent reason that agonistic musical play should end in bloodshed, the prevailing semiosis of contemporary digital games reveals just how readily ludic logic and digital gameplay continue to give rise to sadistic representations.⁴⁸ At the same time, such games demonstrate that, from a strictly ludological standpoint, the structure and dynamics of agonistic competition are more significant than its representational strategies or results. This is why Claus Pias can claim that the "discourse elements" of digital games "are not called 'killing people' or 'catching gold nuggets'" but are instead instantiated through "timeliness, rhythm, or control."⁴⁹ While these latter three elements—all of which are, of course, fundamental elements of musical performance—require digital input from the player, the CPU remains utterly indifferent as to how this input is modulated

and represented. Apollo's impassivity to Marsyas's fate and the musical indiscriminativity of Caus's pegged barrel (Figure 3) are coeval with this formal arbitrariness: from the divinely inhuman perspectives of gods and machines, all meanings are semiotically interchangeable and endlessly deferrable.

Apollo's treatment of Marsyas also lays bare the brutality lurking behind the musical technologies that enable such representations, which is to say instruments themselves. The materials on which Apollo's play depended were scarcely less grisly than its consequences. Despite Roger North's decorous belief that the lyre's strings must have been "mettaline ... or of twisted silk," since only barbarians would have been so "rude and gross" as to handle "gutts and garbages," countless sheep, tortoises, and oxen died alongside Marsyas for its sake.⁵⁰ As Heraclitus observed, the twang of a string can index the discharging of a missile as well as the strumming of a lyre.⁵¹ In 1846, Edward F. Rimbault remarked that "the employment of [catgut] in the warlike bow is supposed to have led to its adoption in the peaceful lyre, owing to the accidental discovery of its musical sound"; reciprocally, Apollo's kithara sounded martial overtones when associated with the bow, his weapon of choice.⁵² Lauding Apollo's mastery over "archery and song," Callimachus drew attention to his instruments' ability to hush the ocean's roar when invoked: "Silent is even the sea when singers celebrate / either lyre or bow, the weapons of Lycorean Phoebus."⁵³ The relation between Apollonian analogies and the violence of the operations that materialized them is commensurate with that between the measurement of pitch and its coordinated impact on the battlefield, first acknowledged by Archytas and later by Vitruvius vis-à-vis the strings of lyres and catapults.⁵⁴

In line with Archytas's and Vitruvius's pneumatic investigations, moreover, the mouthpiece and narrow cylindrical bore of Marsyas's aulos stand in morphological relation to the blowgun, which was also fashioned from reeds, according to Apollodorus of Damascus.⁵⁵ In the course of battle, Apollo and Marsyas were penetrated by sonic signals produced by the other that analogized ballistic missiles in the form of divine arrows or satyric darts. Their contest can thus be understood as a double engagement in sonic warfare between musical instruments as well as between aesthetic, cultural, and religious values. The bows, pipes, hammers, beaters, and other weapons that populate the archaeological record of musical instruments have long stocked an arsenal allowing for the simulation or reenactment of agonistic conflict via play. (In the nineteenth century, these parallels would become explicit not only via the "battle music" of Beethoven, Liszt, and others, but also via the industrialized manufacture of military and musical hardware coupled with the drilling of minds and bodies that sustained the analogous institutions of army and orchestra.)⁵⁶

From this perspective, Apollo's flaying of Marsyas can be construed as the logical continuation of physical hostilities as well as punishment for the latter's hubris. By turning Marsyas inside out, Apollo demonstrated the horror of lit-

eral ex-pression, as Albright shrewdly noted.⁵⁷ At the same time, Apollo revealed the satyr's kitharedic potential: in Ovid's words, "you could count his twitching guts," as if they were offering themselves to be strung and tuned.⁵⁸ Aristides Quintilianus believed that the latticework of strands, sinews, and arteries in the human body analogized the orbits of the planets, just as the strings of the lyre did.⁵⁹ Apollo desubjectified Marsyas by making the satyr's lyric capacity all too enumerable, thereby rendering him digitally assimilable as an object of *harmonia*. As with Phthonos, the metrical ordering of poetry was indistinguishable from the imposition of Apollonian punishment: Marsyas's defeat was enacted and rationalized by the poetic form in which it was rendered.⁶⁰

With their *Theory of Games and Economic Behavior*, von Neumann and Morgenstern showed how the codification of the rules (whether implicit or explicit) governing competitive games can be registered numerically. Any ludomusical battle is a zero-sum game: for there to be a winner, there must be a loser; for a point to be scored, it must be conceded. Ovid recorded Apollo's victory as concisely as letters obeying the rules of Latin grammar could permit: *Phoebo superante pependit* ("[Apollo] won, [Marsyas] hung").⁶¹ To record the result digitally requires even fewer resources: 1–0 will suffice. Recording the tragedy of Marsyas's annihilation in this way depends upon an important epistemological shift, however, as the term "zero-sum" implies.⁶² In order to denote more (or less) than an indivisible unit of construction or calculation within a given class of phenomena—the terms in which Aristotle defined its function—the number one had to be complemented by zero, a concept unknown to the ancient Greeks.⁶³

In 1697, inspired by the mythical Chinese ruler Fu Xi as well as by Christian theism, Leibniz claimed that all the world contained—and all it did not—could be accounted for by the digits 1 and 0.⁶⁴ Inscribed in dactylic hexameter on a medalion he designed to commemorate his own "discovery" of binary (Figure 14) are the words *omnibus ex nihilo ducendis sufficit unum* ("to produce everything from nothing, one [thing] is sufficient"). In Brian Rotman's summary, "the universe (the infinite of numbers) is created by God (the unbroken 1) from the void (the cypher 0)."⁶⁵

But how could the world-making powers of binary be instrumentalized? In addition to its debt to the hexagrams of the *I Ching*, Leibniz's formalization of binary owed much to the realization that any form of message could be encoded by binary means. In 1623, Francis Bacon had remarked that

a way is opened, whereby a man may expresse and signifie the intentions of his minde, at any distance of place, by objects which may be presented to the eye, and accommodated to the eare: provided those objects be capable of a twofold difference onely; as by Bells, by Trumpets, by Lights and Torches, by the report of Muskets, and any instruments of like nature.⁶⁶

Bacon's claim that instruments "capable of a twofold difference onely" could signify, encipher, and transmit over long distances anticipated Samuel Morse's similar



Figure 14 Gottfried Wilhelm Leibniz’s design for a medallion commemorating his “discovery” of binary in 1697. Reproduced from the title page of Rudolf August Nolte, *Mathematischer Beweis der Erschaffung und Ordnung der Welt* (Leipzig: Langenheim, 1734), Bayerische Staatsbibliothek, Munich (Res/4 Phys.sp. 304.25, urn:nbn:de:hbz:12-bsb10908988-2). CC BY-NC-ND 3.0.

technique by more than two centuries, but it was hardly new: slit drums had carried messages along African and Asian valleys for millennia.⁶⁷ Tellingly, however, Bacon’s acoustic triad of bells, trumpets, and muskets groups musical and ballistic devices as “instruments of like nature.” Indirectly, it also raises the question of how the name and function of the key are implicated in cryptography as well as in digital communication. As telegraphy would make evident, a single key can perform and relay a “twofold difference onely” by virtue of Leibniz’s codification of Bacon’s insight: rather than two objects, only one is needed, in conjunction with its absence.⁶⁸ (Here we might recall that “digital” can refer to either a finger or a finger’s breadth.)

The construction of this distinction points up the Leibnizian epistemology that informs von Neumann’s computational architecture. “Ein Ding ist, ist nicht,” wrote Leibniz in the margin of his ruminations on binary arithmetic: as Siegert observes, the aphorism does not represent a logical paradox so much

as the processes of its own writing and our reconstitutive reading, which reveal how things pass into and out of existence when considered from the dimensional perspective of time as well as space.⁶⁹ When set in motion, the pegs studding Caus's barrel (Figure 3) demonstrate how the bits that form stable configurations of memory when arrayed spatially exist only momentarily when sequentially executed as musical code: they are, and then they are no longer. Similarly, over time a key can represent two states: either it is depressed, or it is not. Like all digital media, the key thus offers a way to encipher or decipher, to lock, unlock, or transcode the meanings of notes and letters, and to invoke both plenitude and lack.

Creation *ex nihilo* is also the creation of nothing, and, perhaps most significantly, the creation of the distinction between the one and the other.⁷⁰ In this regard, to invoke Bateson's formulation, the key's informational potential resides in its capacity to articulate "a *difference which makes a difference*," whether sonic, symbolic, or both.⁷¹ Just as the binary distinctions necessary for digital computation and storage are arbitrarily derived from analog fluctuations of voltage, so the digital interface of the keyboard renders sonic materials artificially discrete in order to enable their processing.⁷² *The keyboard filters the complexity of sonic phenomena and their generative mechanisms in order to grant players comprehensive control over the processing of their spatiotemporal configurations, rendering distinctions at once absolute and relative, immediately proximate and infinitely remote.*⁷³ This does not simply represent the hegemony of the digital over the analog, however: on the contrary, the keyboard binds the two together, enabling nonprogrammable humans and sound waves to enter into programmatic relationships.⁷⁴ In Bateson's terms, the keyboard, like the digital computer, is a system built of switches and connectors that both makes and processes differences: the key is depressed (or not), the note sounds (or not) and is heard (or not). But in making audible analog oscillations that can be monitored as well as produced by digital operations, the keyboard also reveals the continuity of difference-making, its prerequisites, and its consequences as in(de)terminable processes in which players, instruments, and listeners alike are enmeshed.

2-2 NOTES ON KEYS

Siegert's magisterial *Passage des Digitalen* exposes the tensions and ruptures between "analog" and "digital" epistemologies that produced new forms of scientific and philosophical knowledge between 1500 and 1900. Negotiations between the properties of continuity and discreteness shaped Leibniz's and Isaac Newton's formulations of calculus and Jean-Baptiste Joseph Fourier's mathematical decomposition of complex signals into their constituent amplitudes and phases, just as they would inform the twentieth-century theorizing of wave-particle duality alongside models of biological processes from evolution and ontogeny to human

cognition and artificial intelligence.⁷⁵ In so doing, they reconfigured conceptual and material relations between space and time, sign and signal, trigger and event.

The broad history of such relationships can be recounted in terms that are at once musical and cosmological, as Daniel Heller-Roazen's summary of how Pythagorean notions of arithmetic and harmony informed musical thought from Boethius to Kant goes to show.⁷⁶ Heller-Roazen's narrative arc traces processes of both disenchantment and liberation: the fi h, dissonant hammer heard by Pythagoras in his legendary forge serves as a metonym for the irrational elements of musical temperament, amplitude, and timbre that defi d all attempts to render them discrete and orderly, necessitating the construction and abandonment of a series of epistemological frameworks. Of particular importance throughout is the distinction Boethius drew between magnitudes, which are continuous and "not distributed in separate parts," and multitudes, "such as a fl ck, a populace, a chorus, [or] a heap of things," which comprise discrete and enumerable elements.⁷⁷ In concert with the complementary distinction between motion and stasis, music, defi ed as the science of multitudes in terms of their shifting relations, took its place within the medieval quadrivium alongside arithmetic (the science of multitudes in their own right), geometry (the science of static magnitudes), and astronomy (the science of mobile magnitudes).⁷⁸

Heller-Roazen observes that Marie-Elisabeth Duchez's reading of notational developments between the ninth and the eleventh centuries "rest[s] on the principle that to be musically intelligible, sounds must be essentially discrete in quantity, like the old multitudes of arithmetic."⁷⁹ For Heller-Roazen, the symbol of the note thus stands as a neo-Pythagorean musical monad: discrete, quantifiable, multipliable, nondivisible. It fi st inscribed the diastematic mapping of frequency onto the page's y-axis before its representational attributes were systematically extended to the temporal domain via the development of mensural notation, which enabled pitch and duration to enter into new types of commutative, isorhythmic, and contrapuntal relations. As David E. Cohen points out, however, the sophisticated semiosis of medieval staff notation was initially grounded in the "iconic representations of instruments" inasmuch as its horizontal lines depicted or alluded to strings, and thus to spatial phenomena as well as to temporal sequences of events.⁸⁰ This suggests that the monochord's pedagogical importance to Pseudo-Odo and Guido of Arezzo lay not only in its Philolaan function of making mathematical relations sensible, but also in the labeling of its tonal partitions by Latin letters. To aid the reader of music notation in the task of converting symbols into sound, these letters operated as *claves* ("keys") that "unlocked" the pitches of their corresponding "strings" when positioned at the beginning of the staff, where they became better known as clefs.⁸¹

If a key thus decoded the symbolization of a material phenomenon, then the development of keyboard instruments enacted the rematerialization of such symbols. Keys fi st appeared as levers that operated organs: labels above the keys of the fourteenth-century instrument in Norrlanda on the Swedish island of Gotland



Figure 15. Keyboard of the Norrlanda organ (ca. 1370–1400). Photograph by Gabriel Hildebrand, reproduced courtesy of the Swedish History Museum, Stockholm.

Figure 16. Reconstruction of Conrad of Zabern's keyed monochord (as described ca. 1460–70) by Hanns Neupert, Bamberg (1954). Photograph reproduced by permission of the Uniseum Freiburg (UAF M 13/54).

(Figure 15), one of the oldest extant examples, correlate the concepts and phenomena of letters, notes, pitches, and *claves*.⁸² In this regard, the keyed monochords described and illustrated by Johannes Keck (ca. 1442), Conrad of Zabern (ca. 1460–70), and their contemporary Johannes Gallicus are especially instructive insofar as they physically perform the Guidonian mapping of the string's ratios.⁸³ On a latter-day replica of Conrad's instrument, built according to his detailed specifications (Figure 16), Pythagorean geometry is analogized, arithmetically seriated, and thus rendered

digitally manipulable via a form of symbolic transcoding that relies on the intermedial functions of the ancient Greek alphabet by way of Guidonian theory and praxis.

Digital communication has primarily to do with the transmission of information that can be measured, combined, and compressed.⁸⁴ From this perspective, the *longue durée* of Guidonian staff notation might be conceived as an era of digitization with regard to *technē* as well as to *logos*. If the lattice of the staff enabled the quantification of musical duration and frequency, and thereby the coordinated assembly and transmission of otherwise inconceivable polyphonic structures, then this grid was most directly materialized by the keyboard's matrix.⁸⁵ For Girolamo Diruta, writing in 1609, the keyboard served as a *cartella*, the erasable tablet on which counterpoint was traditionally sketched; as Mattheson put it in 1739, "the placement, ordering, and numbering of sound is nowhere more distinct and visible than at the keyboard."⁸⁶ The conception and realization of music there involved the digital calculation and performance of the functions symbolized by notation. In Weber's sweeping judgment, the keyboard thus facilitated the integration, differentiation, and manipulation of musical materials with unprecedented efficiency, making it the arch representative of "technical musical rationalization" within the church and throughout the cultural spheres of music orthography, theory, and pedagogy.⁸⁷

That notwithstanding, the hegemony of Guidonian notation and the keyboard owed as much to promiscuity as to reciprocity. As well as plotting pitches and rhythms, notation and its paratextual supplements could encode information and instructions numerically (by figured bass and fingerings) and represent musical style and content alphabetically (by performance indications, note names, solmization, and musical ciphers). For its part, the keyboard's media-agnosticism and one-to-one mapping of notational information enabled it to trade in the symbolic currency of Kittler's "discourse network 1800" via the permutation of letters and numbers as well as notes.⁸⁸ In conjunction with Bacon's and Wilkins's cryptographic insights, the concept and name of the *clavis* indicate how the keyboard was capable of encrypting, transmitting, and decoding information that circulated among senders, receivers, conspirators, and eavesdroppers.

Whereas Jean Paul and E. T. A. Hoffmann chronicled such processes at the piano, Robert Schumann's *lettres dansantes* in *Carnaval*, op. 9 (1834–35, Figure 17, Audio 1), enabled them to be set in ludomusical motion.⁸⁹ Drawing attention to the ludic overtones of the enigmatic strategies that both disguise and disclose *Carnaval's* networks of signification, Schumann informed Ignaz Moscheles that "deciphering my musical masked ball will be a real game for you."⁹⁰ Schumann's game of tones revolved around the symbolic isomorphism of note and letter, as had Chudy's keyboard-based system of long-range transmission devised half a century earlier.⁹¹ Lurking in the margin between text and paratext, *Carnaval's* "Sphinxes" (Figure 18, Audio 2) tacitly stand as guardians and guarantors of the enciphered alphabetic meaning to be found in the various sequences and permutations of dancing letters that Schumann deemed noteworthy.⁹²



Figure 17. Robert Schumann, “A. S. C. H. — S. C. H. A. (Lettres Dansantes)” from *Carnaval*, op. 9 (1834–35), mm. 1–8. Reproduced from *Robert Schumann’s Werke*, ed. Clara Schumann, series 7, *Für Pianoforte zu zwei Händen* (Leipzig: Breitkopf & Härtel, 1879), 11.

Audio 1. Schumann, “A. S. C. H. — S. C. H. A. (Lettres Dansantes),” performed by Sergei Rachmaninoff (929). CC0–1.0.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.2>

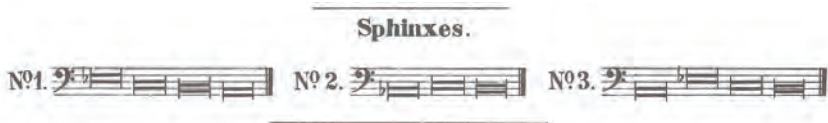


Figure 18. Robert Schumann, “Sphinxes” from *Carnaval*. Reproduced from *Robert Schumann’s Werke*, ed. Clara Schumann, series 7, *Für Pianoforte zu zwei Händen* (Leipzig: Breitkopf & Härtel, 1879), B.

Audio 2. Schumann, “Sphinxes,” performed by Sergei Rachmaninoff (929). CC0 1.0.

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Yet if encipherment and revelation could become entangled at the keyboard, so too could comprehension and delusion, as demonstrated by the research of Eric Sams, who worked alongside Alan Turing as a cryptographer at Bletchley Park during the Second World War.⁹³ While the exact point at which Sams’s zealous pursuit of correspondences between symbols and signification shaded into fanciful invention is up for debate, its deeper meaning lies in its obsession with deeper meaning, exemplary of the Romantic belief that nature and art are “bursting with hermeneutically accessible riches,” as Winthrop-Young puts it.⁹⁴ For Kittler, the conditions of this *Aufschreibesystem* had been established by new techniques of linguistic acquisition centered on the maternal voice that guaranteed the semantic plenitude of utterances while making them alphabetically available for literary concatenation and philosophical abstraction.⁹⁵ Via the discrete continuum of the keyboard, *Carnaval* made sound—the very absence of which could be infused with sphinxian signification—available for hermeneutical processing along analogous lines.⁹⁶

The epistemological imbrication of notes and keys became particularly visible when it was identified as a locus of notational reforms. As J. Mackenzie Pierce observes, the nineteenth century witnessed a proliferation of orthographic and mechanical methods that promised to increase the speed and clarity with which music could be stored on paper, purportedly enabling composers to document even their most febrile inspirations.⁹⁷ Those by Michel Eisenmenger (1838) and Juan Nepomuceno Adorno (1855) melographically remapped the staff directly onto the topology of the keyboard, thereby reversing the process by which notes had been materialized at the Norrlanda organ.⁹⁸ While such methods channeled time-honored technologies associated with hydromechanical and barrel organs, they were more directly associated with the forms and functions of eighteenth-century *Fantasiermaschinen*, devices designed to capture extemporizations at the keyboard by automatically transcribing the player's digital motions.⁹⁹

Even as they improved in accuracy and efficiency, however, such methods revealed with ever-increasing clarity that the note's digital strengths of discreteness and commutability exposed its analogical weaknesses, its inability to trace the audible temporality of the phenomenon it symbolized. Composers who came of age in the later nineteenth century were painfully aware of the fact that beyond scores and other literate texts, in Kittler's words,

Europe had no other means of storing time. Both are based on a writing system whose time is (in [Jacques] Lacan's terms) symbolic. Using projections and retrievals, this time memorizes itself—like a chain of chains. Nevertheless, whatever ran as time on a physical or (again in Lacan's terms) real level, blindly and unpredictably, could by no means be encoded. Therefore, all data flows ... had to pass through the bottleneck of the signifier.¹⁰⁰

While composing *Pelléas et Mélisande* (1893–98), Debussy chafed at these notational limitations, lamenting that he had to represent the “objective, prophetic gentleness of those who are soon to die—all ... with doh, ray, me, fah, soh, lah, te, doh!!! What a profession!”¹⁰¹

Unlike the methods of Eisenmenger and Adorno, stenographic methods such as those developed by Hippolyte Prévost (1833), Stains (1842), and August Baumgartner (1853) could be understood as attempts to record music cursively, inscribing its nuances via the subtle gradations of pen strokes.¹⁰² In this sense, they are not far removed from the undulations of Scott de Martinville's phonautograms, which were also produced without the prospect of mechanical playback.¹⁰³ A crucial distinction can nonetheless be made between stenography, which still encodes, compresses, and represents music primarily in terms of pitch and rhythm via algorithmic pattern recognition, and the mediated immediacy of sound as an oscillographic signal. On the page's y-axis, the alphabetic freehand of Scott's waveforms replaced the staff's grid of frequencies with the registration of amplitude in all its illegible continuity.

Scott claimed that since “phonautographic writing” made visible the oscillographic functions “of tonality, of intensity, of timbre,” it alone could preserve “living

speech”: all other forms of inscription were moribund by comparison.¹⁰⁴ Yet, like Orpheus before him, Scott could be said to have unwittingly required Thomas A. Edison’s assistance.¹⁰⁵ Since humans could not read his inscriptions, it seems all too clear in retrospect that his phonautographic discourse was in need of a media technology that could translate and reproduce it analogically, functions that the keyboard had performed in relation to Guidonian notation.¹⁰⁶ Departing decisively from the digital epistemological lineage stretching from the *Salzburger Stier* to the player piano, Edison’s phonograph provided a technical means of capturing rather than simply representing or triggering oscillographic qualia, of inscribing, storing, and reproducing time in its “blind and unpredictable” unfurling.¹⁰⁷

This distinction helps clarify historical factors behind the twentieth-century opposition of the digital and the analog as they relate to affect and trauma as well as to the fidelity of competing recording technologies. Lacan and Kittler channeled Scott in jointly claiming that the analog is akin to the real insofar as it has no “no” function, and is thus incapable of formally articulating absence.¹⁰⁸ While Philips tried to turn this to their advantage when marketing their first CD player as the “first music reproduction system to reproduce silent passages silently,” the absolutism of digital recording technologies prompted a backlash that forged a thitherto unlikely alliance between proponents of vinyl and advocates for live performance.¹⁰⁹ It is in this light that Jonathan Sterne diagnoses the audiophilic ascription of natural, lifelike qualities to analog recordings and the concomitant association of digitality with mechanicity, deception, and death as symptoms of a nostalgic longing for plenitude that itself cries out for psychoanalytical intervention.¹¹⁰

Anxiety concerning the dehumanizing effects of storing and recreating music has less to do with any particular technology than with the asymptotic approximation of phenomena marked as imperceptible, unrepresentable, vital, and spiritual in the discourse of Romantic *Naturphilosophie*.¹¹¹ In the early nineteenth century, musical automata had formed a prime locus of such anxiety, as recent scholarship has explored in a multitude of ways.¹¹² What affronted the student Ludwig in Hoffmann’s tale “Die Automate”—and the real-life Hegel, for that matter—was not so much the digital mechanicity of automata as their analogicity, their repulsive attempts to mimic the human: “I infinitely prefer the commonest barrel organ, in which the mechanism attempts nothing but to be mechanical, to Vaucanson’s flutist.”¹¹³ Today, Ludwig’s attitude lives on in players of digital games who prefer the unpretentious contrivances of pixel art and chiptunes to dead-eyed three-dimensional avatars rendered in high definition, accompanied by the bathos of sampled orchestral strings, and thereby marooned in the Hoffmannian realm of the uncanny valley.¹¹⁴

In material terms, of course, Ludwig himself was nothing but a concatenation of mechanically reproducible letters, even if he issued from a lurid literary imagination that flew in the face of the alphabet’s constraints in evoking a succession of living, breathing worlds.¹¹⁵ In *Der goldene Topf*, Hoffmann wrote of writing that defied reading, its entangled twirls and flourishes analogizing the

(super)natural phenomena at once related and instantiated via the snake-maiden Serpentina's beguiling narration.¹¹⁶ Bypassing alphabetic symbolization, the intelligibility of Serpentina's speech directly corresponds to the illegibility of its inscription, which Hoffmann describes in terms redolent of Ernst Florens Friedrich Chladni's famous figures.¹¹⁷ In this sense, Hoffmann's mythical script indexes both Scott's phonautographic writing and Edison's technological means of reading it aloud *avant—et après—la lettre*.¹¹⁸

By the early twentieth century, the ubiquity of phonographic realism and the concomitant decline of the player piano indicated that the days of digitally processing, storing, and transmitting notes at the keyboard were themselves numbered. But Hoffmann himself had demonstrated how alphabetic phenomena could be conjured and conveyed by alphabetic media. In notes for a projected essay on keyboard sonatas, moreover, Hoffmann hailed the "perfection of the fortepiano" on account of its affectless presentation of harmonic relationships, the imperious arbitrariness that governed its functions, and the extreme artfulness that could thereby be simultaneously displayed and concealed.¹¹⁹ In this spirit, *la musicienne* (Figures 4 and 5), the eighteenth-century keyboard-playing android whose subtly engineered verisimilitude would have appalled Ludwig, both embodies and foreshadows means by which even the oscillographic signals of thought and sound might be rendered digitally manipulable via discrete operations.

Computer historian Georges Ifrah notes that the programmable controls and subroutines of the Jaquet-Droz androids are protocomputational.¹²⁰ In this regard, the digital encoding of music on *la musicienne's* studded barrel can be related to another idiosyncratic keyboard mechanism constructed a century later. In 1854, George Boole had encoded logical procedures using Leibniz's binary notation, thereby subjecting propositions to algebraic calculation by means of conjunction, disjunction, and negation.¹²¹ W. Stanley Jevons subsequently instrumentalized his own related system of logic in the form of a so-called logical piano (Figure 19), which he presented to the Royal Society in 1870.

Acknowledging his predecessors from Aristotle to Boole, Jevons described his keyboard instrument as an *organon* "capable of exhibiting an answer to any question which may be put to it concerning the possible combinations that form any class," and it is in this capacity that it has been identified as an early materialization of the principles governing functions of digital computation.¹²² Its keys are linked to rods that shift up and down, making corresponding letters visible or invisible through four slot-machine-like slits in the front and rear of the instrument's case that serve as its visual display device. These windows offer a view onto a range of possible combinations that amount to what Jevons dubbed the "logical abecedarium," presenting information that would later be arrayed by Emil Leon Post and Ludwig Wittgenstein in the form of "truth tables" and applied to the correlation of inputs and outputs in digital electronics.¹²³

As Gotthard Günther pointed out, the key is a place at which a proposition, whether logical or musical, may (or may not) be anchored, parsed, and punctuated;



Figure 19. W. Stanley Jevons's "logical piano" (1869). Photograph taken at the Museum of the History of Science, University of Oxford.

as Wilden observes, moreover, negation “involves ‘not’ both in the sense of ‘zero’ and as a rule about zero.”¹²⁴ Substituting propositions for pitches, the “piano” keys labeled with lowercase letters represent the negation of their neighboring uppercase counterparts. Pressing “A” as a “subject key,” as Jevons describes it, “has the effect of throwing all the *a* [“not-A”] rods from the first into the second position,” thus removing them from sight. This goes to show that the performance of digital operations involves the active negation of negation: as Luhmann puts it, negation “requires a positive operation of ‘crossing’ or ‘switching.’”¹²⁵ Accordingly, the adjacent keys marked “A” and “not A” on the logical piano do more than merely articulate the matter of difference in the terms of Bateson, or even the nineteen neighbors of the three keys labeled with an “A” on Conrad’s monochord (Figure 16): they reveal how the difference-making potential of digital technology is itself made (to) matter by symbolic distinctions between presence, absence, and the presentation of absence.

With regard to the automation of thought performed at the interface of the keyboard, both *la musicienne* and the logical piano are distinctly—if distantly—relatable to the epistemological epiphany that took place one storied afternoon in 1936 as Turing lay in Grantchester Meadows, daydreaming of a “universal machine.” In Kittler’s eschatological account, the machine scans for a sign or its absence on a paper strip, at which point

it depends on [the machine’s] reading whether [it] keeps the sign or erases it, or, vice versa, whether it keeps a space blank or replaces it with a sign, and so on and so forth. That’s all. But no computer that has been built or ever will be built can do

more. . . . All data streams flow into a state n of Turing's universal machine; Romanticism notwithstanding, numbers and figures become the key to all creatures.¹²⁶

In line with Flusser's premillennial observations, such a machine processes and transcodes the world digitally: as it calculates the checksum of Hegel's *Phenomenology of Spirit*, each operation stutters or clicks.¹²⁷

Both despite and owing to its devastating simplicity, Kittler hailed Turing's machine as nothing less than the harbinger of a technologically sublime new world order. It staged a recursive coup whereby the digital properties of Leibniz's binary system, ostensibly outflanked and outmoded by the superior sensitivity and verisimilitude of nineteenth-century analog technologies, could render sounds, images, and even the Lacanian realm of the real itself susceptible to the representational symbolism of Boolean logic, soon to be materialized by Claude E. Shannon's electrical circuits and von Neumann's computational architecture.¹²⁸ In sonic terms, the power of automated computation finally enabled quantities of time and frequency, which had previously been melographically encoded on pinned barrels and piano rolls or symbolically plotted along the incommensurable x-axis and y-axis of staff notation, to become mutually calculable via Fourier's mathematical codification of their relationship, the significance of which had been appreciated for more than a century but which was impracticably laborious to perform mentally or manually.¹²⁹

Despite the imaginary origins and idealized ontology of Turing's machine, its coming into being betrayed the fact that even the most abstract of digital concepts must be subjected to materialization and embodiment if it is to make a difference. Just as the computational functions of Charles Babbage's Analytical Engine (1834–71) had been named and explained via analogies drawn from the work carried out in textile mills and storehouses, Jevons relied on the familiar form and function of the piano in order to realize the performance of his logical functions.¹³⁰ Similarly, the epistemological and instrumental implications of the typewriter—and specifically its keyboard—are integral to the systematization of thought identified by Flusser and attributed to Turing by Kittler.¹³¹ Perhaps prompted by memories of his childhood, Turing conceived his machine as nothing less (and nothing more) than a drastically stripped-down single-keyed typewriter capable of recognizing and performing Bacon's "twofold difference only."¹³² Furthermore, the endless tape or paper strip on which its symbols are inscribed and erased evokes the storage media of the type-printing telegraphs designed by Royal Earl House (1849) and David Edward Hughes (1854, a later model of which is illustrated in Figure 20), both of which were outfitted with skeuomorphic "piano" keyboards.¹³³

A trained musician as well as an experimental physicist, Hughes might have been following in the footsteps of Euler, Sulzer, and others when he stumbled upon his design: he was reported to have conceived his telegraph "while endeavoring to contrive a machine for copying extempore music, so that his melodious improvisations

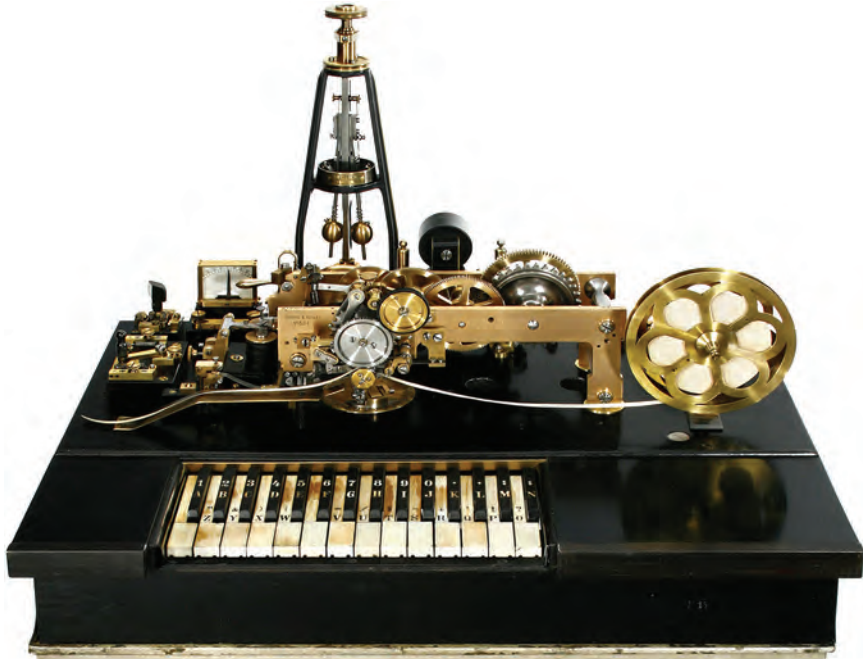


Figure 20. Type-printing telegraph designed by David Edward Hughes (ca. 1880). Photograph reproduced courtesy of the Collection Fons Vanden Berghen, Halle, Belgium.

might not be lost.”¹³⁴ Via the operation of keys, both the telegraph and the *Fantasiemaschine* could encode and inscribe analog signals (whether heard or imagined as music or language) both spatially and temporally in the symbolic forms of dots, lines, and spaces. Meanwhile, the automation of musical keyboards for recreative purposes deployed the same technological means and materials while reversing the direction of their workflow, transforming discrete digital data into continuous sonic waveforms. In 1846, Alexandre Debain introduced his “antiphonel,” a device that sat atop the keyboard of a harmonium or organ in order to recreate music stored on pin-studded wooden planchettes.¹³⁵ Debain’s planchettes resembled the cards used to program looms by Bouchon, Vaucanson, and Joseph-Marie Jacquard; in turn, they would be superseded by the paper-based storage media of the player piano.¹³⁶

For all the boards, cards, and rolls in play, however, the purpose, medium, and content of the transmitted information—and even distinctions between its extemporized generation and its faithful registration—are of limited relevance to the structural relations between symbol and signal established by these keyboard interfaces. More epistemologically significant is the fact that the digital devices of Euler, Sulzer, and Debain processed that information in parallel, thereby enabling

representations of frequency and time, of simultaneity and sequence—or, in musical terms, of harmony and melody—that conform to the domains mapped by the two axes of the page. Conversely, the machines of Jevons, House, Hughes, and Turing were devised to process information serially: strips, tapes, and (for Jevons and Turing) the state of the machine itself replaced leaves and folios.

In this regard, certain technical properties of analog and digital media can be understood simultaneously to diverge and converge. The constant stream of one-dimensional digital data produced and articulated by the keying of telegraphs and typewriters is more akin to the groove of a phonograph cylinder than it is to the coordinated arraying of notes or letters across a page. At the same time, as Feaster notes, Edison's phonographic breakthrough itself issued in part from abortive experimentation with keyboard-based devices for capturing and transmitting what he conceived as the discrete components of speech.¹³⁷ In order for sound to be transmitted, transduced, and heard, the universal machine, the phonograph, and the ear all register phenomena made calculable by the mathematics of Fourier's signal processing.¹³⁸ From this perspective, the most salient parallels and distinctions between the analog and the digital lay in the materials and methods by which the relevant transformations could be performed as well as represented.

The imaginary keyboard of Turing's dream machine recapitulates the automated digital operations of *la musicienne*, the transcription and processing of Hughes's unforeseeable external events (whether musical or otherwise), and the telegraphic encoding of information. At the same time, it supplements the typewriter's mechanisms of alphanumerical transmission and storage with the symbolic logic of computation, endowed with the potential capacity to outdo the analog media of film and gramophone by rendering the world knowable and tangible via digital encoding and analogical transduction, techniques modeled by Jevons's "piano" and the "body" of *la musicienne*.¹³⁹ Across these diverse domains, the keyboard served as a means of imagining as well as realizing symbolic distinctions. For Schumann, musical meanings could be unlocked via keys both played and unplayed; for Jevons, the digital interfaces of piano and telegraph analogized the processing of thought as "played upon [his] machine"; for Turing, the keys that could inscribe and erase a sign were themselves only present *sous rature*.¹⁴⁰ Whether indexing Turing's sign, Jevons's propositions, or Schumann's sphinxes, the keyboard is implicated in the history of digitality via material objects and ideational traces capable of representing and distinguishing between 1 and 0, "A" and "not A," and even the chromatic ambiguities associated with the various means by which "As. C. H." and "A. Es. C. H." could be notified.

In addition to accounting for the epistemological principles according to which keyboards bring concepts, minds, and bodies into communicative contact, however, it is necessary to attend to the cultural conditions under which their functions are

analogized and mediated.¹⁴¹ This entails approaching keyboards not merely as data buses or digital/analog converters, but as interfaces at which information is transmitted, knowledge conferred, selfhood (per)formed, and agency (re)distributed via the digital making of differences.

2-3 INTERFACE VALUES

Since musical interfaces and the effects they produce are as complex as they are varied, a detailed accounting of them requires technical knowledge spanning domains from dendrochronology to materials science. The pages of the *Galpin Society Journal* and the *Journal of the American Musical Instrument Society* testify to the painstaking accumulation of different types of data that, taken as a whole, map out the intricately ramified discourse networks of organology. In many ways, organology's attentiveness to specific instantiations of musical culture and its concomitant suspicion of generalizations derived from sweeping narratives can be seen to have anticipated the recent material and informational turns of the (post)humanities at large. In other aspects, however, structural tensions persist between organology and its sister disciplines of ethnomusicology and historical musicology, not to mention science and technology studies.¹⁴² In particular, ethnomusicologists and historical musicologists have resisted organology's material preoccupations by insisting on interpretations, whether they concern social dynamics, historical forces, or transcendental aesthetics.

Whereas the Hornbostel-Sachs system classifies instruments according to their mode of acoustic production, the interface stands in an orthogonal relation to such taxonomical distinctions. As a schematic morphological principle, it can be put into play with any number of mechanisms—aerophonic (the organ, for example), chordophonic (the harpsichord, clavichord, and piano), idiophonic (the celesta), or electrophonic (from the eighteenth-century *Denis dor*, which charged its metal strings and could shock the player on demand, to the Moog synthesizer)—in order to produce sound.¹⁴³ As Emily I. Dolan and John Tresch observe, the interface of the keyboard has remained a constant element across generations of musical experimentation, skeuomorphically imbuing technological innovations with a comforting air of familiarity.¹⁴⁴ That the keyboard's ubiquity can render it virtually transparent (un)veils the fact that an interface does not simply act as a conduit by which a musical thought is realized; it also conveys the force and inertia of a physical system of checks and balances that trains its players by establishing its affordances and mapping them onto a delimited range of sonic outcomes. Both ideologically and materially, the keyboard partitions and classifies sound, imposing discipline on the generation of acoustic material as well as the body of the player and the sensibility of the listener.¹⁴⁵ *As it orders and arrays musical knowledge, any given keyboard operates as an epistemological object that channels both human and nonhuman forces within a political ecology.*¹⁴⁶

The attribution of a degree of agency to keyboards has a distinguished pedigree in the form of mottoes inscribed on harpsichords and other instruments.¹⁴⁷ Drawing on the classical tradition of epigrams that envoice objects, or *oggetti parlanti*, many such mottoes speak in the first person and are couched in the pedagogical terms of discipline and punishment. Some deploy overtly Foucauldian rhetoric, at once erotic and violent. *Indocta manus noli me tangere* (“unlearned hand, do not touch me”) warns a seventeenth-century virginal, while an eighteenth-century spinet is more ambivalent: *intactum sileo percute dulce cano* (“untouched, I am silent; strike me, I sing sweetly”).¹⁴⁸ Keyboards can instruct and delight even as they suffer at the hands of their assailants: on either side of the interface, “all playing is a being-played.”¹⁴⁹

Harpsichords and their mottoes also indicate how integral digital processes can be to cultural narratives. As Ernst points out, the etymology of “telling” and “recounting” reveals that melodies as well as stories and algorithmic processes comprise signifying objects—notes, letters, or numbers—placed in serial order.¹⁵⁰ In parallel, moreover, the use of digits to measure and calculate at the keyboard informed musical thought and practice across Europe, serving a wide range of analytical and elaborative ends. This was manifested most widely by figured-bass notation and the heuristic procedures that brought about its realization, but it also pervaded the pedagogical domain, from sixteenth-century Iberian alphanumerical tablature and notational systems such as those devised by Antoine Parran and Jean-Jacques Rousseau to the elementary five-finger exercises that established norms of diatonic behavior by allocating numbers to the pupil’s digits.¹⁵¹ It even informed the high-flown theoretical speculation underpinning Jean-Philippe Rameau’s *basse fondamentale*, a calculation of sonorities that is mathematical and philosophical, constitutive and fictive, real and imaginary.¹⁵²

Perhaps most significantly, the pedagogical materials and traditions of *partimenti* operated according to parallel and serial logic, according to which the tactile grip of chordal “handholds” was coeval with the production of linear voice leading that, as François-Joseph Fétis put it, could “sing in an elegant manner.”¹⁵³ Having long eluded the attention of Anglophone scholarship on account of their reliance on manual tradition and lack of an explicit theoretical rubric, *partimenti* have recently been subjected to a flurry of historical and theoretical attention, most notably from Robert O. Gjerdingen and Giorgio Sanguinetti.¹⁵⁴ A *partimento* typically takes the form of a bass line to be realized *ex tempore* by a student at the keyboard. As such, it is a concise script to be decompressed and processed via the hardware of a harpsichord, the interface of its keyboard, and the “wetware” of its player’s experience, skill, memory, and associations en route to becoming music.¹⁵⁵ Rather than a text to be read, it is an algorithmic puzzle that prompts and admits multiple polyphonic solutions.¹⁵⁶

Some *partimenti* provide their players with figures that indicate appropriate harmonies and voice-leading contours to be plotted over it. We might think of these numerals as akin to those that initially populate a Sudoku grid, the number of which defines the puzzle's difficulty: the more accomplished the player, the fewer numerals are necessary. The *partimenti* of illustrious teachers such as Francesco Durante (1684–1755) and Leonardo Leo (1694–1744) reveal that advanced students were expected to extrapolate complex fugues and intricate figuration from virtually unannotated bass lines, yet all this ingenuity was predicated on relatively simple rules (*regole*) governing theory, practice, and the interaction of the two.¹⁵⁷ The identification and realization of contrapuntal and harmonic patterns yielded the default sonorities implied by each scale degree in ascending and descending sequence (the *regola d'ottava*), the treatment of consonance and dissonance, the handling of suspensions and cadences, and methods of devising figuration and embellishment.

At the keyboard, such rules of thumb (and finger) amounted to codes of digital conduct that can be traced back to seventeenth-century traditions of improvising counterpoint: *regole* trained minds and bodies to solve the puzzles of *partimenti* by performing algorithmic and heuristic processes of computation, elimination, selection, and combination in real time, whether they proceeded by *grado* or *salto*, by step or by leap.¹⁵⁸ Such computation could be carried out unconsciously: in Leibniz's evocative phrase, "music is a hidden arithmetic exercise of the soul, which does not know it is counting."¹⁵⁹ This helps explain the phenomenon noted by John Locke, Étienne Bonnot de Condillac, and Denis Diderot in which the cognitive burden of playing—or, in Diderot's case, extemporizing—at the keyboard is delegated from the brain to the digits, thus affording a further instance of the Gadamerian sensation of being played even while playing.¹⁶⁰

For all the keyboard's efficacy as an interface, the notion of play also helps elucidate how its conversion of digital pressure into sound is less than optimally efficient. In this sense, the play of a key, like that of a steering wheel, allows a degree of free motion that is supplementary to that required for its normative function, opening up a space in between compliance and resistance. While it has limited bearing on the instrumentality of the key, this wiggle-room yields haptic sensations that deliver important feedback to the player: as well as providing the technical means of manifesting one's musical will, instruments register and relay the input they receive.¹⁶¹

In this regard, the clavichord is the most analogically expressive of digitally operated instruments, its code of conduct predicated on the almost unbearably intimate translation of touch into sound. Unlike the harpsichord, organ, or (forte)piano, the clavichord responds to the play of horizontal and vertical "aftertouch" at the limits of each key's travel by way of *Bebung*, an intimate vibrato that results from the contact of tangent and string. The acoustic frailty and affective

power of *Bebung* lies in the simplicity and directness of its mechanism: the paradoxical immediacy of mediation via finger and key causes the player's body to resonate in sympathy, making the clavichord an instrument that measures the sensitivity of its operator with unrivaled precision. In his *Versuch über die wahre Art das Clavier zu spielen*, C.P.E. Bach could thus assert that "it is at the clavichord that a keyboard player may be most exactly evaluated."¹⁶²

The oscillographic traces of *Bebung*, the associated dynamic technique of *Tragen der Töne*, and the subtle articulation of release known as *Schnellen* combined to identify clavichordists via a proto-phonautographic signature: listeners registered not merely players' skillful application of these techniques, but the seismic tremors of their very beings.¹⁶³ Charles Burney famously remarked on this phenomenon in relation to Emanuel Bach and his beloved Silbermann clavichord:

In the pathetic and slow movements, whenever he had a long note to express, he absolutely contrived to produce, from his instrument, a cry of sorrow and complaint, such as can only be effected on the clavichord, and perhaps by himself.¹⁶⁴

Burney sensed the presence of Bach's "voice" not via the conventional tropes of *cantabile* and *legato* playing, but by way of the rhetorical, gestural, and timbral force exerted by tangent on string.¹⁶⁵ The clavichord's tone is "alive," as Arnold Dolmetsch put it: "its notes can be swelled or made to quiver just like a voice swayed by emotion."¹⁶⁶ Such sounds were not directly amenable to poetic transliteration; insofar as they could be symbolized alphanumerically at all, they took the vividly onomatopoeic but semantically senseless form of "T'NT!" or "T'T" (as Ernst Wilhelm Wolf articulated the difference made by the correct application of *Schnellen* in 1785).¹⁶⁷

In his *Versuch*, Bach famously exhorted his readers to "play from the soul, and not like a trained bird."¹⁶⁸ Along the lines that Hegel would draw in the *Phenomenology of Spirit*, *Bebung* might stand alongside cursive handwriting as a marker of personal identity that supplemented the self-evident matter of what was said, done, written, and played:

If at first the specific nature and innate peculiarity of the individual, together with what these have become as a result of cultivation and education, are taken as the *inner*, as the essence of his action and his fate, then this essence has its *appearance* and externality *to begin with* in his mouth, hand, voice, handwriting, and the other organs and their permanent characteristics. *Thereafter*, and not till then, does it give itself *further* outward expression in its actual existence in the world.¹⁶⁹

While Bach's clavichord was not one of his own "organs," Burney nonetheless perceived it as a prosthetic extension of his mouth and voice as well as his hand. The relationship of keyboard to body was akin to that between alphabet and cursive script: via the judicious application of *Bebung* and *Tragen der Töne*, the motions of Bach's digits at the keys of his Silbermann could unlock his inner mysteries. The



Figure 21. C. P. E. Bach, *Versuch über die wahre Art das Clavier zu spielen* (Berlin: Christian Friedrich Henning, 1753–62), 2:341.

clavichord rendered his soul not only audible, but also inscribable—and thereby, as Burney proved in turn, legible, describable, and ultimately circulable.¹⁷⁰

The *Versuch* thus stands as an important landmark in the lettering of digital activity, whereby keyboard techniques that had previously been conceived primarily in procedural, algorithmic terms were rendered literary—or, at least, amenable to literary representation.¹⁷¹ At the same time, the technical attributes of the clavichord helped create the conditions under which Bach's *Versuch* could be written. Together with Bach's fantasias, the *Versuch* revealed the clavichord to be a true medium: like the ancient tabula rasa or the cinematic dream sequence, it was capable of serving as a model for the representation of voice, consciousness, and sensory experience. This process of mediation can be traced across the treatise's closing pages, where Bach presented a fantasia in two radically different forms: a fully fledged-out version, (de)noting the piece as realized in performance, and an X-ray of its *Gerippe* ("skeleton"), as Bach called it. The *Gerippe* (Figure 21) consists of what Richard Kramer terms "the 'pre-compositional' calculus of a figured bass," assembled on the page via the discrete components of movable type, whereas the fantasia proper is elegantly engraved, analogizing the contours and arcs traced in the course of performance.¹⁷² The difference between the two representations is itself figured in terms of the skill set of the player able to transcode numbers into affective sensation, particularly at junctures (marked by the alphanumeric symbols in parentheses above the *Gerippe*) where the music self-consciously departs from well-trodden harmonic paths.

In turn, the compelling enumeration of this wayward experience could be alphabetically transposed into the rapturous discursive register in which Burney described Bach's fantasizing at the keyboard, a passage that attests to the clavichord's ability simultaneously to construct subjectivity and to undo it:

During this time, he grew so animated and *possessed*, that he not only played, but looked like one inspired. His eyes were fixed, his under lip fell, and drops of effervescence distilled from his countenance.¹⁷³

Generated from the subconscious and yet precise numerical calculations, Bach's fantasy was performed as a Leibnizian "hidden arithmetic exercise of the soul" in order to be recounted by Burney in terms that shade from *Empfindsamkeit* into the rhetoric of possession associated with Romantic genius—if not madness.¹⁷⁴ Bach's unruly body is figured as blind, mute, and on the verge of delirium: its contents effusively exceed its form, and are thus no longer subjected to—and by—conscious control.¹⁷⁵

In 1804, the keyboard's capacities both to precipitate and to envoice mental derailment were made explicit by Friedrich Rochlitz's fanciful account of his visit to an asylum for the insane: the mercurial fantasies of the inmate "Karl" are musically transcribed as a quasi-etiological record as well as rendered in literary form.¹⁷⁶ The reader is thus provided with the means not merely of vicariously reconstructing Rochlitz's experience, but of inhabiting Karl's musical body at the keyboard, thereby occupying a soul already stigmatized as possessed.

Such pathological tinges imply that the numbering and lettering of behavior at the keyboard were themselves subject to codes regulating the performance of gender as well as music.¹⁷⁷ Daniel Gottlob Türk went to particular pains to warn female students against imitating Bach, drawing attention to the dangers of "indecent facial expressions, squirming, [and] grimacing" while playing the clavichord.¹⁷⁸ For Anton Bemetzrieder, music instructor to Diderot's daughter Angélique (a passionate devotee of Bach's music who proved herself capable of preluding and figuring bass lines in *recherché* harmonic contexts), the alphabetic functions of the harpsichord's keyboard formed the basis of an elaborate didactic analogy between music and language that left little room for fantasy or caprice.¹⁷⁹

On a grander pedagogical scale, the blind Austrian keyboardist Maria Theresia Paradis, godchild as well as near-namesake of the Habsburg empress, demonstrated that language acquisition, letter writing, musical performance, and composition—not to mention games of chess and cards—could be conducted exclusively via the manipulation of discrete objects and symbols, testifying to her dexterity and adaptability as well as to her intellect, memory, and refined sensibility. Paradis accrued substantial cultural and economic capital: her condition was treated by Franz Mesmer, the inventor Wolfgang von Kempelen designed a *Handdruckpresse* (a typewriter that purportedly printed the letters of the



Figure 22. Frank Haven Hall's Braille Writer 1, serial no. 25, made by Harrison and Seifried, Chicago (1892). Photograph reproduced courtesy of the Martin Howard Collection (antiquetypewriters.com).

Figure 23. Hope Simmons at Samuel W. Francis's "literary piano" (1857). Photograph taken at the Smithsonian Museum in 1928 (Library of Congress LC-USZ62-62968).

alphabet via the leverage of keys) for her personal use, Mozart furnished her with a keyboard concerto, and she studied composition with both Anton Salieri and Georg Joseph Vogler.¹⁸⁰

The development of media technologies by Paradis and her acquaintances compensated for the lack of vision and inability to write cursively that might otherwise have thwarted her cultivation of selfhood. Far from confining her to the margins of society, as the same condition did for so many others, Paradis's blindness confirmed Diderot's philosophical contention that an enlightened subject could be constructed and represented by the manipulation of discrete elements—notes, letters, numbers, and keys—via haptic and digital means alone.¹⁸¹ In this context, it is telling that attempts to synthesize, capture, and transmit the human voice—the supreme index of subjectivity—by Kempelen, his contemporary l'Abbé Mical, and subsequently Hermann von Helmholtz and Joseph Faber (not to mention Edison) relied on the manipulatory and regulative aspects of the keyboard.¹⁸² Toward the end of the nineteenth century, these elements were compounded by Frank Haven Hall's Braille writer (1892, Figure 22), which enabled blind subjects to express—or rather emboss—themselves alphanumerically at the keyboard by playing chords that generated Louis Braille's six-bit code. In terms of its communicational protocol, Hall's keyboard relied on the same digital techniques and technologies that Chudy and Baudot had devised to telegraph one's thoughts to a recipient who was out of sight.¹⁸³

Despite their emancipatory potential, however, all these tactile technologies and bodily techniques were liable to be construed along gendered lines: if a man at a keyboard was heard to “play from the soul,” the playing of women was heard merely to transfer “the chatter of their tongues to the clatter of the keys.”¹⁸⁴ Referring to the skeuomorphically “musical” operation of type-printing telegraphs and typewriting devices such as Samuel W. Francis's “literary piano” (1857, Figure 23), Raykoff expands on Kittler's mordant observation that the telegraph and the typewriter coopted the dexterity of female pianists, capitalizing both on the fluency of finger they had acquired through countless hours of practice and on the concomitant capacity to digitize male utterances—whether musical or bureaucratic—dutifully and accurately.¹⁸⁵

Although they can be traced back to the eighteenth century, the codification of expressive protocols and the gendered bureaucratization of piano technique were closely aligned with the design and production of musical and communicational instruments throughout the nineteenth century.¹⁸⁶ As many have acknowledged, the social impact of the piano is calculable on no less than an industrial scale: even as the piano became synonymous with bourgeois cultivation and leisure, its affordance of play hinged on a proto-Fordist ideology and division of labor.¹⁸⁷ On the one hand, the proliferation of pianos across Europe and North America facilitated the rapid spread of the notion that the musical soul was digitally articulable; on the other, this proliferation relied on the technological resources of

hammer mills and even knitting frames, exposing the mechanization that lay at the heart of the pianistic enterprise from manufacture to pedagogy.¹⁸⁸

Within the black box of the Steinway, the morphology and function of Apollo's kithara remained, but multiplied, transformed, and devolved. The number of strings grew more than thirtyfold; the lyre itself, far too heavy to be supported by the human body, was sealed out of sight; the essential task of tuning was assigned to a trained professional, disconnecting mathematics from the domain of the player's senses; the strings were not plucked by fingers, or even by the plectra with which Apollo endowed the harpsichord, but rather were struck by felted descendants of the hammers wielded by Pythagoras's blacksmiths. The musical forge lay hidden behind the fallboard: as with the personal computer, only the interface of the keyboard provided sanctioned access to the instrument's inner workings.¹⁸⁹

As a result, the signature sounds of cultivated sensibility reverberated through every bourgeois household, produced and recognized via pedagogical methods that inculcated the performance of auditory discrimination, manual dexterity, and expressive gesture as fundamental cultural techniques (even if *Bebung* had to be sacrificed for the sake of increased amplitude and lower maintenance costs). At the same time, the standardization of repertorial software—in other words, the process of canon formation—and the vogue for transcriptions displaced responsibility for individuation from improvisatory facility onto the art of interpretation and the craft of reproduction. The crusade against soulless “monochromatic” piano playing launched by the journal *Le pianiste* in the 1830s was aimed at the benighted masses who placed “les notes avant la musique, la lettre avant le sens” by mechanically rendering the score as instructed, evoking the algorithmic obedience of *la muscienne*.¹⁹⁰ Yet the format, medium, and circulation of *Le pianiste* were themselves symptoms of the mass-reproducible musical culture that it decried: in black and white, its alphabetic print made plain the journal's own reliance on the “signes froids et limités” that it urged its readers to transcend.¹⁹¹

Even so imaginative an exponent of transcription as Liszt was ambivalent about the artifacts generated by the digital dithering of symphonies, string quartets, and operas at the keyboard's dichromatic interface, which could evoke tonal colors via chiaroscuro alone. Comparing transcriptions to mass-produced engravings of famous paintings, Liszt identified the practice with the economics of commodification: the portability, popularity, and exchange value of the four-hand transcription relied on the piano's attributes as a highly efficient quantizer, compressor, and decoder of discrete data, benefits that came at the expense of timbral and temperamental nuances.¹⁹²

In compensation for these shortcomings, the free flight of the piano's hammers, which detached human stimulus from sonic response, prompted attempts to

account for the mysterious idiosyncrasy of touch by investigative means that sometimes verged on the occult. For the prominent pedagogue Marie Jaëll, who had studied with Liszt, touch could be decoded only by studying fingerprints as distinctive traces of digital identity.¹⁹³ Supplementary meanings accrued on either side of the piano's interface: beyond the matter of digital operations, embodied actions and acoustic signals were made momentous by extravagant gestures and wishful listening that implored the instrument to perform the sonically impossible.¹⁹⁴

In this sense, too, the keyboard could act as a medium between the living and the (soon-to-be) dead by serving as a vehicle for memory and the historical imagination. After Mozart's departure for Vienna at the end of Eduard Mörike's novella *Mozart auf der Reise nach Prag* (1856), Eugenie, who had engaged in flirtatious badinage with the composer and had been captivated by his lively genius, was filled with melancholy foreboding:

She felt as if she were dreaming, when she thought who had been sitting there, only a few hours ago. Long and pensively she gazed at the keyboard which he had so recently touched. Then softly she shut the lid and turned the lock, putting the key in her pocket, with jealous care that no other hand should open it for a long time to come.¹⁹⁵

For Eugenie, as for Jaëll, the keyboard bore its player's fingerprints as a mark of his inimitable identity. She wished that the instrument were capable of (re)storing the memory of Mozart's touch and sound instead of indifferently returning to its blank default state in anticipation of the next player. Seeking at least temporarily to defy the heartless commutability of digits, keys, and *marceaux sans maîtres*, Eugenie willed the keyboard into becoming a medium capable of reconnecting her to Mozart, of preserving the presence of his absence.¹⁹⁶ To this end, the keys themselves had to be locked away, their capacity for play negated by their withdrawal from social intercourse.

2-4 (KEY)BOARD GAMES AND TEMPERAMENTAL TACTICS

As noted in Key 1, musical contests throughout the history of Western music have featured the keyboard as the black-and-white field of play. Under the terms of such contests, the keyboard is a tabula rasa as well as a site for archaeological investigation: as a ludomusical schema, it affords a particular set of tactics for constructing relationships between sign and signal, body and sound, player and played. Operating as a means of quantization capable of unambiguously distinguishing identity from difference, the keyboard established the prerequisites for fair contests and the establishment of their outcomes that were conspicuously lacking from Apollo's duel with Marsyas.

Yet, as Bourdieu observed and the stakes of such contests bear out, the demarcation of such a field of play for the staging of duels typically serves the purposes of cultural elites. The keyboard is not only emblematic of rationalization insofar as it ensures “predictability and calculability beyond local differences and particularisms”; the very notion of the fair play that it regulates betrays the aristocratic pride taken in the conspicuous display of disinterest that measures the distance between play as “activity for no purpose” and the vulgarity of its material consequences in sport just as in art.¹⁹⁷ At the same time, as Lévi-Strauss pointed out, placing players on an equal footing is a mere prelude to the process of distinguishing between them as winners and losers: at the keyboard’s symmetrical grid, the making of differences tends to yield asymmetrical results.¹⁹⁸ *In this sense, the very literality of analogies between music and games at the keyboard outlines the complexity of their social and political ramifications as well as the ways in which they inflect concepts of musical autonomy, form, and reference that have been primarily grounded in the ontology of the musical work.*¹⁹⁹

The genealogy of the keyboard’s explicitly ludomusical potential extends back to the chekker, a quasi-mythical fourteenth-century keyboard instrument whose form and function have generated much debate.²⁰⁰ No chekkers are extant, and the only iconographical material that has been presented as evidence for the instrument’s design, produced by Jean Gerson in 1424, postdates its heyday and is obscurely allegorical in nature (Figure 24). “At once musical and military,” Gerson’s image depicts a chessboard primed to stage an agonistic battle between vices and virtues. Underneath the board, strings are said to resonate when activated by the chekker’s keys, implying a clavichord-like mechanism that registers the pitch and position of each “piece” by “checking” (fretting) the string corresponding to its file at the appropriate rank. The chekker thus combines a dichromatic matrix with an invocation of the ludic play characteristic of keyboard technologies and techniques in general, revealing that these elements were integral to the idea of the keyboard from its earliest days. Strengthening the notion that the clavichord’s keyboard originated as a means of partitioning strings in order to subject their sonorities to mathematical interrogation, this suggests the means by which number could stand alongside note and letter as symbolic material to be processed at the keyboard.²⁰¹

Since checkerboards were also widely used for the public performance of financial reckoning, it is telling that Marin Mersenne and Kircher referred to the keyboard as an “abacus.” Nicolas Meeüs speculates that the analogy held because “the keyboard materialized the system of sounds much as the abacus visualized that of numbers.”²⁰² The calculating abacus was represented in terms redolent of musical notation, and vice versa: while Christopher Page points out the bead-like qualities of Guidonian notation, Meeüs draws attention to the “musical” typesetting of Balthasar Licht’s treatise on the algorithmic rules governing the operation of the abacus (1509, Figure 25).²⁰³ This representational reciprocity

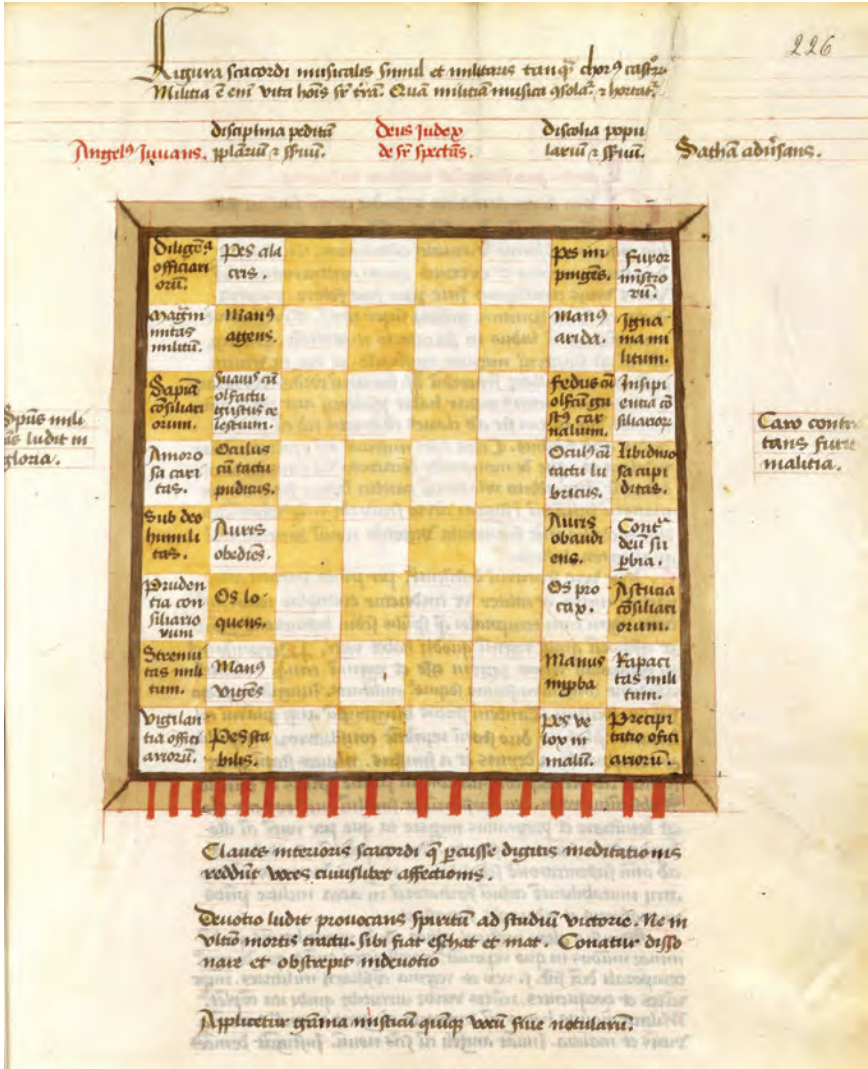


Figure 24. Jean Gerson, *Figura scacordi musicalis simul et militaris tamquam chorus castrorum* (1424). Reproduced courtesy of Daniel Hobbins and by permission of the Bibliothèque nationale de France (MS lat. 17487, fol. 226r).

refl cts the material and iconic attributes of strings as spatial and temporal axes in the context of calculation as well as music. Kramer’s analysis of the “calculus of [the] figu ed bass” that undergirds the fli ht of the fi al fantasy in C. P. E. Bach’s *Versuch* echoes Helmholtz’s observation that while “thoroughbass is a kind of applied mathematics,” its effects were capable of exceeding the scope

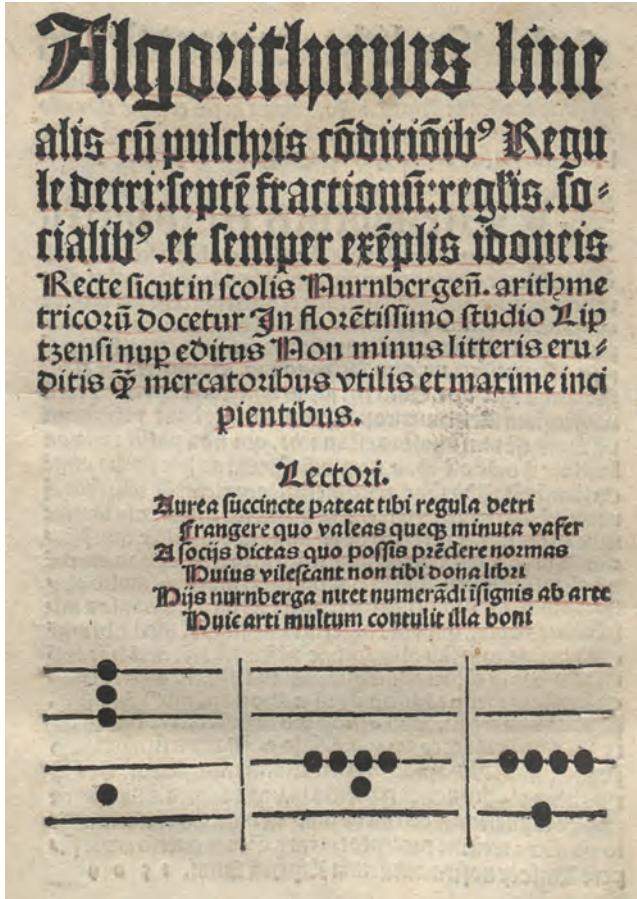


Figure 25. Balthasar Licht, *Algorithmus linealis cum pulchris conditionibus Regule detri . . .* (Leipzig: Melchior Lotter, [1509]), title page, Bayerische Staatsbibliothek, Munich (Res/4 A.gr.b. 65#Beibd.1, urn:nbn:de:bvb:12-bsb00006584-4). CC BY-NC-SA 4.0.

of rational discourse, including Helmholtz's own: "Mathematics and music! the most glaring possible opposites of human thought! and yet connected, mutually sustained!"²⁰⁴

Cash registers and other adding machines demonstrate how keyboards could connect the mathematical and the musical by facilitating human involvement in computational processes. Beyond that, as we have seen, digital interfaces provided Turing with the metaphorical apparatus capable of representing computation itself. Following Shannon's implementation of Boolean logic via relays and switches, the computational leap from counting to reasoning enabled a new order of digital play predicated on the principles of Jevons's logical piano. The five-note keyboard of



Figure 26. *Doom piano* (2013), made for the Arcade Jam at the Virgin Media Game Space by George Buckenham, Sos Sosowski, David Hayward, et al. Photograph reproduced courtesy of Sam Hughes, The Sound Architect (thesoundarchitect.co.uk).

Video 2. *Doom piano* at the Eurogamer Expo 2013. Reproduced courtesy of Outside Xbox (youtube.com/outsidexbox).

To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.4>



beatmania operates as a set of Boolean gates that map directly onto the game's own logical determination of ludic outcomes. The input of players is both registered and parsed by the very same Boolean means, ensuring that their digital propositions, conjunctions, and negations meet with the appropriate consequences.²⁰⁵

If *beatmania* foregrounds the digital interface that helped make computational processes conceivable and transmissible as well as musically manipulable, then the *Doom piano* (2013, Figure 26 and Video 2) conflates its attributes to surreal effect. This singular instrument combines the ludomusicality of the checker, the computational principles behind the logical piano, and the lurid violence of Apollonian agonistic conflict waged according to the principles of von Neumann's game theory and materialized via his computational architecture.²⁰⁶ In the genealogical context of *beatmania*, the *Doom piano*'s unexpectedly familiar interface strengthens the case that the adoption of the keyboard as the default input device for the personal computer was neither self-evident nor merely a matter of historical and cultural contingency: rather, it marks the unpredictable continuation of a long-running thread of digital techniques intertwined with music, figures, communication, calculation, and the playing out of conflict.

In computational as well as musical terms, however, the keyboard has not exclusively operated as a binary digital interface. The fifteenth-century keyed

monochords of Keck, Conrad, and Gallicus demonstrate that the keyboard can facilitate analog computation that, like a slide rule, models the very phenomena it seeks to measure.²⁰⁷ The fine detail of such analogical mappings can be directly indexed by the topographical features of the keyboard itself. This tendency was most evident in the sixteenth and seventeenth centuries, when instruments such as the *archicembalo* of Nicola Vicentino, the *cembalo triarmonico* of Giovanni Battista Doni, and the *clavemusicum omnitonum* of Vito Trasuntino rendered the keyboard's interface more temperamentally granular in the service of transposition, modulation, historical speculation, and neoclassical experimentation.²⁰⁸ Such ventures are documented in Kircher's *Musurgia universalis* (1650), which illustrates seven "abacuses" ranging from the familiar "Halberstadt" layout putatively established by Nicholas Faber in 1361 to enharmonic architectures distributing up to thirty-two keys across four planes to cover the compass of a mere octave (Figure 27).²⁰⁹

Aside from the *Tetris*-like tessellation of the keys on Kircher's abacuses, enharmonic keyboard designs that invoke the isomorphic properties of Gerson's allegorical chessboard are of particular ludomusical interest. At isomorphic keyboards, the spatial relationship between any two pitches is topologically equivalent regardless of transposition. Early gestures toward isomorphism include Francesco Nigetti's modifications to the design of Vicentino's *archicembalo* and the enharmonic *Hammerklavier* built in Vienna by Johann Jakob Könnicke to Johann Georg Roser's specifications (ca. 1796, Figure 28).²¹⁰ On this six-manual instrument, reputedly played by both Haydn and Beethoven, the thirty-one equal-tempered pitches per octave are symmetrically distributed over forty-two keys in a six-by-seven grid redolent of the QWERTY keyboard (an analogously tabular interface that would emerge from the comparable scale of the task of alphanumeric representation). The eleven "redundant" keys per octave facilitate substitutions that render seven different fingering patterns sufficient to account for all thirty-one of the instrument's tonalities.²¹¹

Going even further, each of the fifty-three equal-tempered keys per octave of James Paul White's fully isomorphic "harmon" (1883, Figure 29) is labeled with a color or ludic symbol a knight's remove from its nearest counterpart, which sounds its diatonic neighbor in Pythagorean terms.²¹² By representing this fifty-three tempered musical space in the manner of a post-Eulerian *Tonnetz* (a connection demonstrated by Helmholtz's student Shohé Tanaka, who invented a justly tuned "enharmonium" and produced a theoretical and historical account of intonation that deployed Riemannian lattices), White's isometrically rotated keyboard encouraged players to plot and execute tactical sorties across musical territory in a manner more closely akin to the nineteenth-century *Kriegsspiel* than to the dichromatic maneuvers of chess.²¹³ Whether triangular, square, or hexagonal, such grids are ubiquitous today in games of strategy and role-play played on

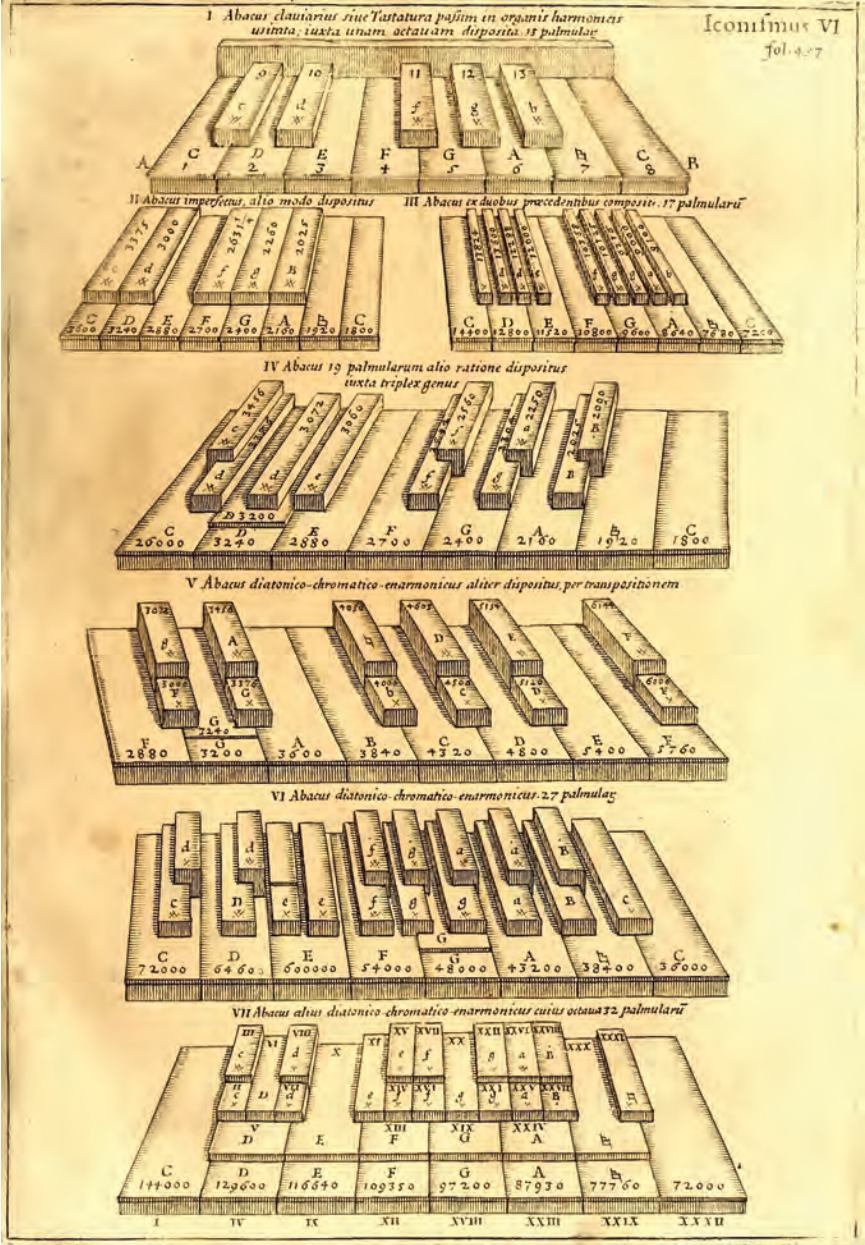


Figure 27. Athanasius Kircher, *Musurgia universalis, sive ars magna consoni et dissoni* (Rome: Francesco Corbelletti, 1650), 1:457.

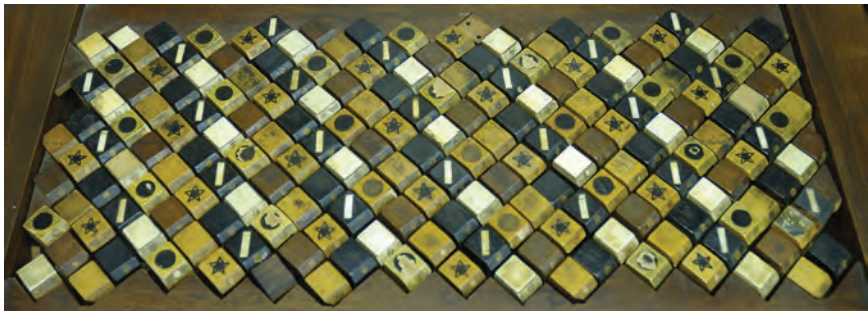


Figure 28. Johann Jakob Könnicke, *Harmoniehammerflügel* (ca. 1796). Photograph reproduced by permission of the Kunsthistorisches Museum, Vienna.

Figure 29. James Paul White, “Harmon no. 3” (1888). Photograph by Andrew Hurlbut, reproduced courtesy of the New England Conservatory.

boards and computers alike, as illustrated by *Hex* (1942/47/52, Figure 30), and they continue to inform the design of musical interfaces such as Erv Wilson’s and Siemen Terpstra’s honeycomb-like isomorphic keyboards (the latter of which is illustrated in Figure 31)²¹⁴

As with the diverse motivations and effects associated with the operation of Baudot’s five-bit keyboard interface, the relations between these multiple iterations of analogous topologies are better understood in terms of media operations—combinations, loops, recursions—than they are as symptoms or outcomes of linear historical processes. Independent of their revolutionary or reactionary motivations, materializations of microtonality via keyboard interfaces can be understood from a media-genealogical perspective to perform the Democritan function of increasing digital granularity, thereby bringing symbol and signal into closer alignment and minimizing the distortion associated with

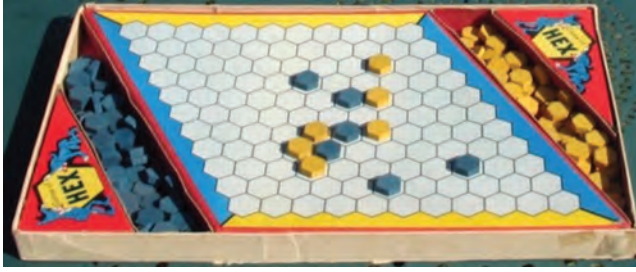


Figure 30. *Hex* (Parker Brothers, 1952), independently devised by Piet Hein (1942) and John Nash (1947). Photograph by François Haffner. CC BY-SA 3.0.

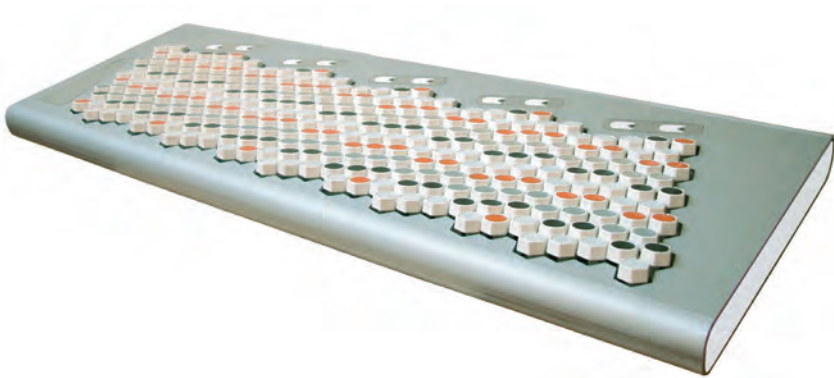


Figure 31. Keyboard after Siemen Terpstra's design (ca. 1988), built for Johnny Reinhard (2007), engineered by Dylan Horvath with Garnet Willis and Joel Mandelbaum (terpstrakeyboard.com). Image reproduced courtesy of Bo Constantinsen (whatmusicreallyis.com).

quantization. Media-archaeological evidence can thus help clarify how divergent ideas have been channeled by the same means and materials as well as how similar concepts have been susceptible to different representational strategies.

Accordingly, we should be wary of attributing overarching motives or functions to the persistence of the “Halberstadt” layout, which, despite the biases reflected and wrought by its tonal and diatonic asymmetries, has often been correlated with the hegemony of twelve-note equal temperament and, more recently, the tyranny of MIDI.²¹⁵ It is undeniable that the gradual equalization of keyboard temperament resolved irregularities and nuances into a pattern comprising discrete and fungible steps, an epistemological *gradus ad Parnassum*. Operating along permutational rather than proportional principles, moreover, the keyboard facilitated the quantization, assimilation, manipulation, transcription, and dissemination—which could be said to amount to the colonization—of all kinds of music. Invoking

Hector Berlioz's description of the orchestra as "subordinate to the action of an immense keyboard played on by the conductor following the directions of the composer," Dolan shows that the keyboard has instrumentalized musical hierarchies by acting as a vector of control, forcing the music and bodies of others to conform to its grid.²¹⁶ If, in Cage's words, "tuning is another form of government," then equality of temperament by no means accords with the equality of the people whose musical actions it has systematized, regulated, and excluded.²¹⁷

Yet the ubiquity of twelve-note equal temperament and its Halberstadtian manifestations should not render us insensible to the fact that from *slendro* to the Bohlen-Pierce scale, every tuning system makes an ideology audible, however (un)justly it might strike our ears. By eschewing any pretensions to Pythagorean purity, the keyboard could serve as a test bed for the development and application of transpositional permutations and enharmonic modulations that offered unprecedented opportunities for musical exploration. As Diderot and Bemetzrieder conspired to claim, enharmonic relationships among the twenty-four major and minor keys were akin to detours and short-cuts in an "immense labyrinth" through which "one can wander in a thousand different ways" in search of "successful tonal combinations" at the harpsichord, that "happiest invention."²¹⁸ The exploration of harmony's obscure recesses equipped the intrepid keyboardist with the means of calling forth silence and darkness, plaintive cries, and the horrors of the night in quick succession; conversely, "by moving a single finger," she might evoke "pleasure, laughter, play, romance, tenderness, and delight," if the fancy took her—and all in the course of accompanying a single recitative.²¹⁹ At the keyboard, enharmonic digital maneuvers can lead to the mapping of musical experience in all its kaleidoscopic variety as well as to the (trans)formation of the musical self. The keyboard's boundaries might corral an "encapsulated microecology," as Richard Cohn characterizes classical models of diatonic space.²²⁰ But Cohn also demonstrates that the "systemic closure" imposed on the *Tonnetz* by equal temperament opens up new aeronautical and geometrical possibilities in the form of hexatonic orbits and excursions into Weitzmann regions, maneuvers often based on the movement of "a single finger" that were pioneered at the keyboard by Schubert, Liszt, and others.²²¹

Conceiving of the keyboard as a cultural as well as a digital interface allows us to register how its means and ends have varied drastically over space and time. The pursuit of its ramifications takes us far beyond European borders: long before its industrial heyday, the keyboard was a site of technological exchange that staged the encounter of Islamic model-making traditions, the Chinese invention of the escapement mechanism, and the application of other insights gained from the engineering of astronomical instruments and mechanical clocks as well as the manufacture of psalteries and dulcimers.²²² Furthermore, the establishment of twelve-note equal temperament might itself be attributed in part to the Chinese scholar Zhu Zaiyu, who articulated its principles in 1584, a year before the Flemish

polymath Simon Stevin's first published pronouncements on the matter provided mathematical clarification of its fundamental irrationality.²²³ As Stevin observed in 1605, the frequency ratio of a semitone can be expressed as the twelfth root of two; while such irrational numbers might horrify Pythagorean purists, Turing demonstrated that they are nonetheless computable. Yet the processes by which such computation is materialized involve negotiation and compromise as well as the approximation quantified by the decimal fractions popularized by Stevin. In practice, the acoustic effects of the piano's inharmonicity and the consequent stretching of its octaves mean that some of its equally tempered intervals are more equal than others.

The predominant configurations of keyboards today at once mask and lay bare this complex genealogy. Outwardly, the straight lines and hard surfaces of the grand piano are supplemented by the curve that indexes the ratios of Apollo's kithara. At the matrix of the keyboard, the digitality of finger, key, note, and Boolean logic intersects with the analogicity of embodiment, signal, and irrational number; behind the fallboard, the keyboard's arithmetical mapping of frequency is made geometrically audible. The keyboard is material and ideal, manipulable and manipulative, obfuscatory and revelatory. It both constitutes and represents a field of play on which systematized actions and reactions unfold according to certain rules, but the stakes, the means of regulation, and the interpretation of outcomes are all contingent and contestable. In short, the matter of the keyboard is not black and white—except, of course, that it is.

2-5 TRISTAN'S CHORD, SCHOENBERG'S VOICE

The keyboard's capacity to encode and decode the content not only of musical notation but of literary, numerical, and other informational systems via transcription, transduction, and computation helps explain its position as the default interface in historical terms as well as in our own multimedia age. Unlike typewriters, organs, player pianos, and even *la musicienne*, however, Turing's imaginary machine and modern digital computers are capable of recursion, of inspecting their own states and programmatically altering their actions correspondingly. How might a harpsichord, clavichord, or piano compare on these terms?

A discursive strand running from the eighteenth century to the present day suggests that such keyboard instruments could indeed be imagined to operate recursively insofar as they were deemed capable of representing their own representational functions. Purportedly in conversation with Jean le Rond d'Alembert, Diderot wondered what the consequences would be if harpsichords were endowed with the ability to perceive and remember.

Imagine a harpsichord with sensation and memory, and tell me whether it will not repeat by itself the tunes you play on its keyboard. We are instruments endowed with

sensation and memory. Our senses are merely keys that are struck by the natural world surrounding us, keys that often strike themselves.²²⁴

In Diderot's thought experiment, the harpsichord's capacity to read and repeat gives rise to an awareness of its own state and a power to act accordingly—a degree of recursive autonomy usually reserved for human consciousness or digital computation.²²⁵ By imagining the harpsichord to be alive, self-aware, and even capable of generating offspring, he was treating it as an integrated media system capable of transmission (via play), reception (sensation), storage (memory), and reproduction.

On the one hand, Diderot was drawing attention to the mechanistic principles and properties that animate humans and other life forms. On the other, he was performing a boldly vitalistic maneuver vis-à-vis the vibrant matter of the harpsichord: life is not grafted onto it from the biological realm, but is to be found in the sympathetic resonance of the strings its keys activate, as Condillac, Jean Gerson, and Aristides Quintilianus had previously intimated.²²⁶ Herder, too, was struck by the keyboard's recursive properties, its materialization of natural law (alongside the alphabet, the rainbow, and calculus), its ordering of knowledge, and its capacity for play and calculation: "Music plays a clavichord within us, which is our own most intimate nature. . . . It is not we who count and measure, but rather nature; the clavichord within us plays and counts."²²⁷ Herder located the source of music not in the rational mind, or even in Leibniz's unconscious soul, but in the common nature that he held to define humanity from both within and without.²²⁸

Although the prominence of the keyboard in Diderot's and Herder's discourses seems to strengthen its claim as a means of demonstrating the harmony of the universe by digital means, each author's metaphorical strategy betrays a degree of anxiety.²²⁹ As Dolan points out, Herder was deeply suspicious of claims that equated mathematical or acoustical elegance with aesthetic value: he considered instrumental music to be particularly susceptible to the charge of scientism.²³⁰ For his part, Diderot was acutely aware of the solipsistic delusions that attended the mapping of sensory data onto cosmic ontology. Even for harpsichords, that way madness lies: there is "a moment of delirium when a sensitive harpsichord thinks it is the only harpsichord in the world, and that it alone is responsible for all the harmonies of the universe."²³¹

Alongside Burney's descriptions of Bach inspired and possessed at the clavichord, Herder's evocation of nature and Diderot's description of the delirium induced by keys and resonating strings anticipate the Hoffmannian lettering of Romantic consciousness, made and unmade through music by way of—and yet despite—its instrumental materialization. In this regard, Diderot's harpsichord found a Romantically recursive counterpart in Berlioz's macabre description of an Érard piano endowed with memory, and thus driven mad, by thirty consecutive performances of Felix Mendelssohn's Concerto in G minor, op. 25, at the

Paris Conservatoire's concerto competition. Just as Diderot had imagined (and Mörike's Eugenie had implicitly desired), the Érard started "repeating by itself" the figures played on its keyboard; despite the best efforts of all concerned, it could be silenced only by consignment to the flames of a nearby locksmith's forge.²³² For Berlioz, the rationalizing forces of pedagogical, institutional, repertorial, and instrumental mechanisms combined to supremely irrational effect. If Eugenie bemoaned the keyboard's inability to remember digital distinctions, then Berlioz warned of the perils attached to the repetitive drilling that rendered them unforgettable.

Berlioz's cautionary tale also suggests that the shifting vectors of natural, cultural, scientific, and technological power in relation to human agency can be traced via the roles assigned to the keyboard and its players. For the nineteenth-century physiologist Johannes Müller, the keyboard provided an analogy for the control exerted by the human will over the nervous system: "the fibres of all the motor, cerebral, and spinal nerves may be imagined as spread out in the medulla oblongata, and exposed to the influence of the will, like the keys of a piano-forte."²³³ Similarly, as Scherer, Veit Erlmann, and Benjamin Steege have pointed out, Helmholtz invoked a pianistic analogy when describing the auditory perception of pitch, mapping Alfonso Corti's anatomy of the "innumerable plates" within the cochlea's basilar membrane onto the discrete operations of "keys" that decompose incoming sonic waves into their constituent elements according to the mathematical functions formalized by Fourier.²³⁴ For Ernst Kapp, in whose philosophy of technology all tools and media were apprehensible as prosthetic projections of their physiological origins, Helmholtz's anatomical explanation of music's Pythagorean mysteries revealed that the key to the form and function of the modern piano had been held all along as a secret within the innermost recesses of the ear.²³⁵ If Helmholtz were right, music would prove to be a hidden arithmetic exercise of the body rather than the soul.²³⁶

As Steege notes, moreover, no homunculus was seated at Helmholtz's microscopic keyboard: in a maneuver that undermines Müller's faith in an omniscient will, "the agent pressing the keys has disappeared."²³⁷ Extrapolating this tendency, the biologist Jakob von Uexküll invoked the keyboard not as a neurological switchboard, but rather as a matrix representing the systematic principles behind the ecological networks (*Umwelten*) that surround and sustain all living beings.

Countless *Umwelten* compose ... the keyboard on which Nature plays her symphony of meaning, beyond time and space. In our lifetimes, in our *Umwelten*, we are given the task of forming a key in the gigantic keyboard, over which an invisible hand glides, playing.²³⁸

By 1940, the scope of the soul was no longer analogizable by a keyboard's broad compass, as it had been for Diderot and Herder. For Uexküll, the task of

fashioning a single key was more in keeping with humans' place in the order of things; the luxury of play was reserved for Nature, at once anthropomorphized and disembodied.

As the keyboard's analogical scope narrowed, the reach of Turing's universal digitality expanded. By the later decades of the twentieth century, even fewer retained faith in the dexterity of the hands, whether invisible or phantasmic, charged with ensuring the harmonious cooperation of society and the self. Thus Flusser undertook his own thought experiment centered on the "new human being" of the future, who no longer possesses hands but uses the tips of his fingers

to tap on keys so as to play with symbols. The new human being is not a man of action anymore but a player: *homo ludens* as opposed to *homo faber*. Life is no longer a drama for him but a performance. It is no longer a question of action but of sensation.²³⁹

What governs and regulates the performance of this *homo ludens*, fused with his keyboard? For Flusser, the answer lay in the cybernetic function of the key itself:

Keys are devices that permutate symbols and make them perceptible: *viz.* the piano and the typewriter. Fingertips are needed to press keys. . . . I choose a key, I decide on a key. I decide on a particular letter of the alphabet in the case of a typewriter, on a particular note in the case of a piano . . . [But] the freedom of decision of pressing a key with one's fingertips turns out to be a programmed freedom. A choice of prescribed possibilities. I choose according to the regulations (outlined in the manual).²⁴⁰

The field of the keyboard might afford "infinite substitutions in the closure of a finite ensemble," as Derrida put it, but such ludic infinity is conceivable only under the digital imposition of strict limits and absolute distinctions.²⁴¹ Moreover, at Flusser's imaginary keyboard, as at Turing's, the processing of data and the enforcement of commands become formally indistinguishable.²⁴² Flusser's player is no longer played in accordance with the composer's whims, Nature's mysterious laws, or Hegelian historical imperatives.²⁴³ Instead, play itself becomes a function of recursion, trapping players within the logic of the system, sardonically described by Flusser as "extremely satisfactory"—by which he meant totalitarian.²⁴⁴

In "Chamber Music," the essay quoted in Key 1–5, Flusser celebrated the collaborative ludomusical potential promised by the "telematic" keyboard play of the future. Here, conversely, Flusser—who suffered terribly at the hands of a totalitarian regime—registered the threats represented by such play and the abdication of the self, however temporary, that it demands.²⁴⁵ In different ways, systems of twentieth-century music composition and theory imposed arbitrary rules while legitimating them with the political or spiritual rhetoric of necessity.²⁴⁶ At Heinrich Schenker's hands, the significance of musical symbols emerged not from their

audible relations in and to the world, but from their recursive processing of one another in conformity with contrapuntal law. The generative logic of serialism, a system imaginable only under the temperamental equality imposed by the keyboard, was matched by analytical methods derived from combinatorial logic and Shannon's information theory.²⁴⁷ At Darmstadt and beyond, algorithmic models and techniques also informed the automated (re)production of synthesized, aleatoric, stochastic, and minimal music; even timbre and dynamics, the oscillographic remainders of Romanticism, were not immune from quantization and systematization.²⁴⁸ Flusser suspected that the compelling internal logic of such processes masked the fact that their operations were divested of human significance: subjected to autotelic recursion, they canceled themselves out, leaving only the tapping of keys, the permutation of symbols, the meaningless oscillation of bits or strings.²⁴⁹ In such a scenario, the orbits of the planets represent not the rapture of cosmic *harmonia*, or even the musico-mathematical maneuvers of a *Glasperlenspiel*, but merely the playing out of events that are at once arbitrary and overdetermined.

Whether manifested as mosaic, montage, remix, or mashup, the medium-agnostic principles of transcoding and recombination continue to define the predominant aesthetic protocol of our times. Despite Flusser's anxieties, however, even the most avowedly mechanical play can still surprise, touch, and unsettle when its digital elements are charged with analogical power. The composer and sound artist Tristan Perich has derived much of his work from binary principles, deploying traditional instruments such as the harpsichord and piano alongside "1-bit electronics" whose musical signals are transmitted with maximal informational economy.²⁵⁰ Performances of these works invite listeners to contemplate points of contact between human and machine while compelling them to confront the keyboard's digital lineage and the technological means that connect soundboard and circuit board, score and code, traveling key and vibrating speaker cone.

While it can be heard to emerge directly from the crudely pixelated sound-world of chiptunes and early digital game music, Perich's work is thoroughly Leibnizian, and not only to the extent that its 1-bit epistemology bears out Leibniz's motto (*omnibus ex nihilo ducendis sufficit unum*). The development of Leibniz's binary thought was dialectically entwined with his principle of continuity, founded on the premise that noticeable perceptions arise by degrees from phenomena that are too minute to be registered, but that can nonetheless be divided into innumerable monadic constituents.²⁵¹ Perich's *Microtonal Wall* (2011, Figure 32 and Video 3) is composed of fifteen hundred speakers arrayed in a grid somewhat analogous to the isomorphic keyboards of Könnicke and White (Figures 28 and 29). Across the range of four octaves, each speaker plays a discrete frequency, precisely interpolated with those of its nearest neighbors, that can be aurally resolved only at close quarters. At a distance, the microtones coalesce into a mighty chord of white noise, bearing out Leib-



Figure 32. Tristan Perich, *Microtonal Wall, 1500 Divisions of the Four Octaves from D_3 to D_7* (2011), at the Lydgalleriet in Bergen, Norway. Photograph reproduced courtesy of Tristan Perich.

Video 3. Perich's *Microtonal Wall* at InterAccess, Toronto. Reproduced courtesy of Tristan Perich.



To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.5>

niz's famous observation that the tiny sounds made by individual waves collectively compose the roar of the sea.²⁵² By digitizing Leibniz's analogy, Perich's wall draws attention to its individual components, the process of their aggregation, the technological means that realize both, and the overarching epistemological principles that sustain awareness of all three.²⁵³ The wall tests the limits of (ap)perceptual resolution, encouraging listeners to discover the threshold at which organized sound gives way to noise, multitudes to magnitudes, the lyricism of Apollonian order to the oceanic scope of the poetry favored by insatiable Phthonos.²⁵⁴

Whereas Perich's wall materializes a Leibnizian thought experiment via signals and speakers, *A Letter from Schoenberg* (2008), created by Peter Ablinger with Winfried Ritsch and Thomas Musil, derives its analogous effect from the interface of the keyboard.²⁵⁵ Although it might be understood as a distant descendant of *la musicienne*, Ablinger's work makes no attempt to simulate the outer form of a human; instead, it outsources the eighteenth-century android's digital functions to a *Vorsetzer* that covers the keyboard of a conventional piano.²⁵⁶ In accordance with the principles of the player piano, the "digit" for each key takes the form of a computer-controlled actuator endowed with the ability to play with superhuman velocity: collectively, they can trigger as many as sixteen distinct events every second (the temporal threshold that, Ablinger claims, marks a perceptual boundary between the discrete and the continuous, analogous to the auditory limits probed by the frequencies of Perich's wall).²⁵⁷



Figure 33. Arnold Schoenberg at home in Los Angeles with his Webster-Chicago “Electronic Memory” wire recorder (1948). Photograph by Richard Fish, © Arnold Schönberg Center, Vienna. Reproduced by permission.

The “text” of *A Letter from Schoenberg* consists of an analog sound recording made by an angry Arnold Schoenberg in 1951 using his Webster-Chicago “Electronic Memory” wire recorder (Figure 33), in which the composer dictates a letter to the record company executive Ross Russell that berates and threatens him for “publish[ing René] Leibowitz’s performance of my *Ode to Napoleon* with a woman [*sic*] voice.”²⁵⁸ Rather than digitizing Schoenberg’s words at a typewriter, as the composer had presumably intended, Ablinger and his collaborators played them back at the piano’s keyboard (Figure 34 and Video 4).²⁵⁹ After being subjected to spectral analysis, the recording of Schoenberg’s voice was vocoded into a detailed stream of MIDI data used to program the *Vorsetzer*.²⁶⁰ The resulting recreation of the sound and sense of Schoenberg’s voice is uncannily lifelike, even



Figure 34. Peter Ablinger, *A Letter from Schoenberg* (2008). Photograph reproduced courtesy of Zeitvertrieb Wien Berlin.

Video 4. Performance of Ablinger, *A Letter from Schoenberg*. Reproduced courtesy of Peter Ablinger and Zeitvertrieb Wien Berlin.



To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5252/luminos.16.6>

as its conspicuous reliance on technological resources—which, in Hoffmannian terms, “attempt nothing but to be mechanical”—ironizes Schoenberg’s own outrage at an instance of unauthorized sonic reproduction (Leibowitz’s recording of the *Ode to Napoleon*) via an unratified medium (a voice of the “wrong” gender).²⁶¹

Like Perich’s wall, *A Letter from Schoenberg* problematizes both analogies and distinctions between form and content, signal and noise. It might also be set alongside Cory Arcangel’s *Drei Klavierstücke op. 11* (2009), a video montage that algorithmically reconstructs the pitches and durations of Schoenberg’s landmark opus via roughly commensurable interactions between cats’ paws and keyboards mined from YouTube.²⁶² Both works are supremely digital to the extent that they filter “Schoenberg” through the grid of the keyboard, subjecting the composer to a pixelated caricature of his own combinatorial methods. Yet, as Daniel Walden has noted, Schoenberg himself had sought to combine the functions of piano and typewriter to make sound representable via digital means capable of bypassing human consciousness: in 1909, he designed a musical typewriter (*Notenschreibmaschine*) capable of producing no fewer than 120 discrete notational elements which promised to generate “unforeseen effects” via the musical possibilities that its keys rendered tangible.²⁶³

Ablinger's *Letter* tests the audible, representational, and technological limits of digital granularity by featuring the piano itself as a medium charged with transmitting the dead composer's disgruntled voice.²⁶⁴ Its dissonances distantly echo Bach's "cry of complaint" at the clavichord, not to mention the febrile outpourings of literary characters such as Honoré de Balzac's Paolo Gambaro and Thomas Mann's Adrian Leverkühn, both of whom are driven into delirium by the task of transcoding sound via digital activity.²⁶⁵ But Ablinger's work goes further by realizing at the piano what Mörike's Eugenie could only tacitly and vainly desire in the wake of Mozart's departure. *A Letter from Schoenberg* mediates between the living and the dead by exploiting the fact that computation according to the principles codified by Fourier can inform and transform the fine-grained mechanical manipulation of the keyboard's discrete interface via the plotting of temporal and spatial clusters. Dithering the keyboard's normatively crude quantization of pitch and rhythm, these clusters approximate the analog fluctuations of Schoenberg's voice. At once generator, resonator, and ventriloquist, the piano performs the very functions that Helmholtz attributed to the "keys" and "strings" within the cochlea. Ablinger's *Letter* thus makes the past present by incorporating the physiological attributes of finger, voice, and ear, combining the recreative and reproductive technologies of Caus's digital barrel (Figure 3) and Schoenberg's analog "Electronic Memory," fusing the epistemologies of Leibniz and Turing, and even effecting an imaginary reconciliation between the Lacanian registers of the symbolic and the real.²⁶⁶ By way of the piano's acoustic properties as well as its digital input mechanism, the poet's roar is rendered with Apollonian clarity, its semantic sense and seismic force simultaneously enciphered and unlocked by the play of the keys.

Flusser's fears notwithstanding, human actions can still invest play with transformative power.²⁶⁷ Equally significant are the ways in which the interactive dynamics of musical play at the keyboard trace the complex formations of historical and media-archaeological discourse. *As a field of play, the keyboard offers access to a wide range of ludomusical experiences, whether performed as recreations of prior events, conceived as simulative praxis under a particular set of cultural conditions, or configured in the infinitely finite terms of an emergent improvisatory process.*²⁶⁸ From Shakespeare to Ablinger, the keyboard has sustained technological fantasies both predicated on and made parsable by digital analogies, and it will doubtless continue to do so in ways that are yet to become conceivable. The keyboard's persistence as an interface, its patterning of fixity and flexibility that has at once resisted and accommodated change, forms a shifting boundary that connects and separates worlds, joining and cleaving human and machine, player and played, the analog and the digital. The play of the keys demonstrates how a system operates, but also probes its limits. Whether we choose to play along or to rewrite the rules of ludomusical engagement remains up to us.

Par t II

Play by Play: Improvisation, Performance, Recreation

Lusus enim suum habet ambitum.

[The game has its own bounds.]

—Moz ar t t o Leopold Moz ar t, November 14, 1777



The mergence of Musical Play

Marooned somewhere south of the Aleutian Islands, Lemuel Gulliver was relieved at the prospect of rescue by inhabitants of the flying island of Laputa, devoted as they were to the noble pursuits of music, mathematics, and speculative learning. Gulliver was quickly dismayed, however, by the Laputans' self-absorption and the casual cruelty with which this led them to treat others. In a thinly veiled satirical swipe at British foreign policy, the small island exerted colonial power over Balnibarbi, the land beneath its orbit, by maneuvering into position to launch airstrikes at restive regions—and even to block the sun's rays from reaching them.

While touring subjugated Balnibarbi, Gulliver was shown around the Grand Academy of Lagado. All manner of Laputanesque experiments took place there, from the extraction of sunbeams from cucumbers to the softening of marble in order to make it a more suitable material for pillows. Perhaps most impressively pointless was an enormous machine, or "Literary Engine," consisting of wooden blocks linked by wires and covered on every face by pasted squares of paper over which the local lexicon had been arbitrarily distributed in its entirety (Figure 35). On a professor's signal, forty students turned cranks that rotated the blocks, producing a fresh permutation of words on their uppermost faces. Thirty-six then read through the resulting "texts," dictating any passages that happened to approach the threshold of semantic sense to the remaining four, who logged the resultant broken sentences in "several Volumes in large Folio." The professor proudly informed Gulliver of his intention to piece them all together, and thereby "out of those rich Materials to give the World a compleat Body of all Arts and Sciences."¹

Written in 1724, this episode of *Gulliver's Travels* lampoons the experimental zeal and lack of practical acumen that Jonathan Swift imputed to the denizens of

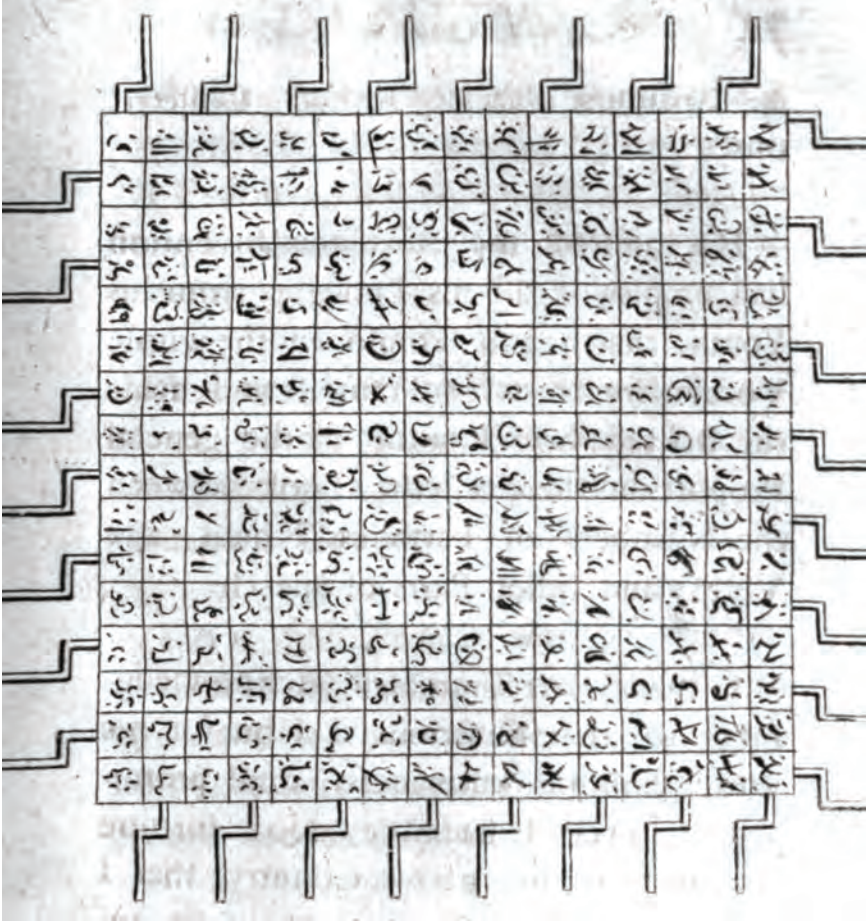


Figure 35. The Literary Engine in the Grand Academy of Lagado, Balnibarbi, reproduced from Jonathan Swift, *Travels into Several Remote Nations of the World* (London: Benjamin Motte, 1726), 2: plate following p. 74.

the Royal Society, who represented an influential stratum of the British elite that his Luptan conceit critiqued more broadly. Beyond its immediate historical targets, the ongoing relevance of Swift's celebrated satire is borne out by the fact that it has yet to go out of print. In this regard, the professor's Literary Engine, founded on the "strictest Computation of the general Proportion there is in Books between the Numbers of Particles, Nouns, and Verbs, and other Parts of Speech," was still operating alongside the ambitious mechanisms of Babbage's Analytical Engine, designed more than a century later.² Furthermore, the jumble of letters produced by the hand-cranking of the Literary Engine bespeaks the metaphysical lineage

invoked by Jorge Luis Borges in “The Library of Babel” to illustrate the (in)imitability of canonical literary works by way of the (ir)rational mathematical scope of the *ars combinatoria* as reckoned by Llull, Paul Guldin, and Leibniz.³

Rather than voltage fluctuations and logical states, the Literary Engine’s media of transmission and storage consist of ink and paper, combined in the form of inscriptions on pasted squares and logged entries in the professor’s volumes respectively. From a media-genealogical perspective, Swift’s satirical engine can nonetheless be understood as a data point on a trajectory that charts the generation and analysis of information via the play of mechanical operations.⁴ Today, the same permutational mechanisms, equally oblivious and yet preternaturally attuned to human-based notions of value and capital, drive the mighty engines of knowledge under the proprietorship of Google and Yahoo. In an exquisitely recursive twist, their operations have been reapplied to literature—including, of course, *Gulliver’s Travels*, in which the anthropoid Yahoos made their debut. The professor’s “several Volumes” have grown into a Brobdingnagian machine-readable and -writable database that admits and answers questions on a scale as nonsensical as it is sublime.

In musical terms, Mersenne calculated that the writing down of every possible twenty-two-note melody would take twenty-three billion years and result in a stack of paper reaching from the earth to the stars.⁵ Since the Literary Engine processed fungible units of information with a sublime disregard for their semantic content or syntactical coherence, it could easily be modified to produce such a copious quantity of cut-and-pasted musical non sequiturs, as William Hayes, Oxford’s Heather Professor of Music, caustically noted in 1751.⁶ Adopting a Swiftian tone in the course of impersonating Barnabas Gunn, an erstwhile rival who had won the coveted position of organist at Gloucester Cathedral, Hayes launched a mordacious attack on what he lampooned as the indolent, trivial, and effeminate qualities of Gunn’s favored Italianate idiom.⁷ The “wonderful Invention of the learned Professor mentioned in Captain *Gulliver’s travels*” would have been the perfect means for composing such music “by a Method so easy, that a Child of Five Years may do it—as well as myself.”⁸

Derrida could have been describing the Literary Engine when he defined play as the mechanism by which the bounded field of language could generate countless utterances via “infinite substitutions in the closure of a finite ensemble.”⁹ Amid his playful cogitations on the idea and multifarious forms of paper machinery, Derrida wrote of the ambiguous relations that obtain between the teleological assembly of works, the endless weaving of texts, and the undecidability of the question whether the serious business of cataloging knowledge incorporates or emerges from the ludic happenstance of *un coup de dés*.¹⁰ An irrepressible sense of play enlivens the satirical registers of both Swift and Hayes, which depend upon virtuosic wordplay as well as a keen sense of the absurd.

In both cases, however, play is the target as well as the mode of discourse. For Swift, the vanity and folly associated with the Laputans and their Balnibarbian representatives are exposed not only by their lack of pragmatism, but also by the meaninglessness of their autotelic pursuit of activities for their own sake, characteristics closely associated with play. For Hayes, the “Ease and Negligence” of Italianate music posed a threat to the “manly Strokes of *Handel*” precisely because composers such as Gunn rejected all pieces “that have the least Appearance of Labour and Study in them.”¹¹ The English-born composer, singer, and keyboardist Elisabetta de Gambarini went so far as to teach “the Proportions of harmonical Sounds, by the Pippis on Cards,” a use of ludic accoutrements that aroused Hayes’s suspicion: even when put to pedagogical ends, play undermined the Northern European virtues of industry and utility, and its blandishments were not to be trusted.¹²

Scorning geographical borders and prejudices, the dice game (*Würfelspiel*) became the predominant format of ludomusical play across the whole of Europe over the latter half of the eighteenth century.¹³ Such games are algorithmic, and thus prescriptive rather than descriptive: rather than merely representing symbolic data, they program procedures. Alongside a database of pitches and rhythms and a tabular index, *Würfelspiele* provide users with instructions on how to tally dice rolls in order to assemble successive measures of simple compositions in popular dance genres. *Würfelspiele* designed by (or spuriously attributed to) Johann Philipp Kirnberger, Maximilian Stadler, Haydn, Mozart, and many others thus operated as paper machines, procedurally generating virtually innumerable outcomes via “substitutions in the closure of a fin te ensemble.”

The methods by which *Würfelspiele* incorporate the operations of chance expose unwritten rules of play in the form of stable harmonic and syntactical features that are designed to accommodate and process the contingency of melodic and rhythmic variation. Blurring Derrida’s sharp distinction between the diligent production of knowledge and the whimsical operations of chance, *Würfelspiele* exhibit systematic and structural means of ratifying, ordering, and cataloging data that can withstand—indeed, that depend on—incursions of the unknowable. Dice games can thus be conceived as systems that put sound into play via oscillations between the predictability of material and ideational constraints and the unforeseeable performance of actions that are at once voluntary and arbitrary.

Whether presented satirically or in earnest, and whether marketed as whimsical pastimes or professional shortcuts, *Würfelspiele* reflect the codification of contingency and its impact on musical realms over the course of the Enlightenment. Across the historical milieux traversed by Krajewski in his account of the genesis of the card catalog, and in line with the theoretical models he constructs alongside Derrida’s, the ludic functions of dice games as paper machines draw attention to parallel manifestations of the same principles in literary, economic,

ethical, and mathematical circles.¹⁴ Moreover, they suggest that pedagogical methods—and, as proposed in Key 4, even normative musical scores—might also be understood to operate as ludomusical paper machines. *Whether manifested by the strategic manipulation of notational systems or the generation of improvisatory comedy, the playfulness of eighteenth-century musical texts was coordinated by complex interactions between inscriptions, tables, calculations, mechanisms, and procedures that were typically performed at the keyboard.*¹⁵

The eighteenth-century loci at which the epistemological principles of the *Würfelspiel* were most prominently materialized are the card catalog and the lottery, associated with Gottfried van Swieten (Prefect of the Viennese Imperial Library and patron of Haydn and Mozart) and Friedrich Wilhelm Marpurg (director of the Royal Prussian Lottery and close colleague of C.P.E. Bach), respectively.¹⁶ Today, the functions of library and lottery—which, independently of serious or frivolous affect, involve the organization and the organized *dis*organization of information, respectively—fall under the aegis of the digital computer's databases and random number generators, both of which are also integral to its games. As if anticipating this convergence, Abbé François Rozier proposed in 1775 that the index of the publications issued by the Académie des Sciences in Paris should be distributed across a voluminous series of playing cards owing to their standardized format, which, as Krajewski notes, allowed for “easy shuffling [and] afforded robust handling.”¹⁷ In this light, it is telling that the pages of certain *Würfelspiele* were designed not to be sequentially read, but to be detached, dismembered, and reassembled into a deck of cards that would give rise to music only when they themselves were played.¹⁸

When accounting for the extemporized past, historical narratives have tended to reenact the literary logic of the archive that informs and regulates them.¹⁹ Modeling improvisatory maneuvers with catalogs, lotteries, and digital games in mind leads away from the couching of such narratives in literary tropes and toward an archaeological concern for materiality and its ludomusical mediation that can itself be legitimated on historical grounds. This entails recasting the functions of musical texts, bringing them closer to the nonlinear modes in which the randomly accessible skills associated with spontaneous music-making are processed and imparted by the mind and at the keyboard. Via thoughts, bodies, texts, objects, and instruments, improvisation choreographs the fragile concatenation of meaning from preexistent elements even as it accedes to the anarchic law of entropy in staging its evanescence. On the one hand, drawing attention to the singular circumstances of its emergence allows us to calculate its debts to mechanisms of combination, memory, habit, and tradition; on the other, it reveals how the supposedly reiterative, nonimprovisatory acts of reading, writing, performing, and replaying can themselves be as unpredictable as they are unrepeatable.²⁰

Rather than denaturalizing improvisation by purporting to restore its historicity in the forms of distance, loss, and alienation from the vantage point of the here and now, this Key departs from the premise that the matter and means of musical emergence can be conceived as always already and as always yet-to-be historical. Aiming to elude Romantic binaries concerning the (ir)rational, the (un)predictable, and the (un)inspired while pursuing Sulzer's claim that nature is "an infinite resource for artificial machines that surpass all human inventions," it recounts a natural history of mechanical musical improvisation by considering how vital and automatable processes collude to form systemic affordances and constraints from which novelty can emerge.²¹

From *Würfelspiele* to *partimenti*, the playful business of generating music in real time falls primarily under Caillois's rubric of *alea*, but its subjunctive attributes are also informed by the ludic logic of *mimicry*. This becomes particularly apparent when the means and motives of musical improvisation are set alongside their theatrical counterparts in the extemporized traditions of the *commedia dell'arte*, which infiltrated the performance of *opera buffa* as well as the ludic dynamics of identity, uncertainty, and disguise that drove the social play of pantomime, masquerade, and carnival. Moving across these worlds and activities, the figure and music of Mozart provide points of access to the question of how ludomusical systems could produce a compelling blend of the novel and the familiar by giving rise to structures that were at once open and closed, under- and overdetermined.

By the early nineteenth century, however, the increasingly sophisticated means by which such systems could be engineered only exacerbated their aesthetic failings insofar as the multiple outcomes of their generic play flew in the face of the specificity and singularity demanded of the musical work. Diederich Nicolaus Winkel's "componium" (1821), a sophisticated mechanical organ capable of "improvisation," stands as a site at which Romantic conflicts between the vital and the mechanical were played out. Analogously, *Sid Meier's C.P.U. Bach* (1994) sets the rule-bound calculation of contingency and the imperative of compositional authority on an anachronistic collision course that nonetheless sheds historical light on the conceptual and technological apparatus on which the play of *Würfelspiele* and the operation of the componium relied.

The algorithmic and contingent qualities of musical dice games and their successors do not obviate their textual attributes: on the contrary, the notion of the paper machine invites us to consider how the aleatoric interweaving of musical material enacts the very process by which texts come into being, and thereby to reframe the relational functions of text, improvisation, performance, and recreation. Beyond the page, however, addressing extemporization as a mode of digital and analogical play allows us to record the interaction of its permutational and processual elements more clearly than words permit. The operations of paper and silicon machines draw attention to the common ways in which texts and other devices

have prompted ludomusical behavior, whether its rules are materially enforced, explicitly stated, tacitly implied, or embedded in the unwritten protocols that regulate generic or topical conventions. The pursuit of these connections promises to reveal relations between the playing out of extemporized events over the course of the long eighteenth century and their subsequent echoes and afterimages. Registering the wooden, metallic, and corporeal elements from which *Würfelspiele* were sonically realized thus enables us to take a step toward bringing the textual traces of historical play into closer contact with contemporary ludic worlds.

3-1 UNFOREHEARD CIRCUMSTANCES

If, as Caillois claimed, the outcome of play must not be knowable in advance, then a paradoxical question emerges: How can uncertainty be guaranteed?²² The activities that Caillois filed under the category of *alea* include coin-tossing, roulette, and lotteries, all of which rely on rigid formal or material constraints that resist manipulation by the player (or anyone else) by denying access to crucial elements of information and control, which are instead distributed across the ludic system. This unknowability gives rise to contesting interpretations: Do the operations of chance unfold in the name of destiny, exigency, and fate (personified for the Greeks by Ananke) or capricious happenstance (overseen by Tyche)?²³ What accounts for the blind inconstancy of the world? Might causeless instability itself be responsible for the emergence of (dis)order and (mis)fortune?

While games cannot deliver definitive answers, they can pose, simulate, and reframe these questions in ways that reveal how seemingly insignificant differences in the definition of a parameter or the making of a decision can have far-reaching and unintended consequences.²⁴ The structure of games brings together the ostensibly opposed elements of necessity and arbitrariness in the form of rules that are finely tuned to give rise to events that are at once explicable and unforeseeable. Analogously, improvisation models and emulates the emergence of complex phenomena from relatively simple rules and materials.²⁵ On its most ambitious scale, the variation and selection of such emergent processes can be mapped onto the evolution of life itself as well as its simulation via cellular automata, most famously exemplified by the mathematician John Conway's *Game of Life*, the rules of which were first published in 1970.²⁶ Although the meaningless diversions of *Würfelspiele* might seem to occupy the opposite end of this spectrum, their epistemological frameworks share the same premises while elucidating the mechanisms by which previously unheard musical material can be spontaneously generated.

Leonard G. Ratner observed that "the spirit of the *ars combinatoria*, the master game, appeared as valid for music as it did for mathematical speculation in the eighteenth century."²⁷ As demonstrated by Ratner, and more recently by Sebastian



Figure 36. Kircher's *arca musarithmica* (1650), presented to Augustus the Younger, Duke of Brunswick-Lüneburg. Photograph reproduced by permission of the Herzog August Bibliothek, Wolfenbüttel (Cod. Guelf. 90 Aug. 8°, Heinemann-Nr. 3876).

Klotz and Gerhard Nierhaus, the algorithmic mechanics of *Würfelspiele* were spun off from the combinatorial and calculative logic adumbrated by Lull and Mersenne, formally articulated by Leibniz, and concretized in different musical forms by Kircher and Lorenz Christoph Mizler.²⁸ Kircher's *arca musarithmica* (1650, Figure 36) is a box containing wooden rods (*tariff*) that tabulate musical phrases, modes, and poetic meters to enable the algorithmic composition of "simple" and "fl rid" vocal counterpoint.²⁹ On the one hand, the *arca* represents an unusually sophisticated materialization and automation of musical principles first articulated by Joachim Burmeister (1606) and Diruta (1609), constructors of contrapuntal "boxes" whose contents could be unpacked and artfully arrayed

as exercises in compositional technique; on the other, it divests this artisanal responsibility to the aleatoric play of permutational principles.³⁰ The technically acceptable polyphony that emerges is predictably crude: both its serviceability and its inelegance derive from the arbitrary decisions made by its operator within the constraints of Kircher's rules.

The *arca's* tabular indexing of musical information bears an isomorphic and even an operational resemblance to Danckerts's chessboard canon (Figure 2). While Kircher's *arca* can churn out any number of boilerplate solutions, Danckerts's canon challenges the player to find the optimal answer to a devious puzzle. To the extent that both draw attention to the intelligence of their design, however, they share the theological premise that mechanisms of invention merely reveal what was already latent in God's originary acts of creation. Conversely, the ludic contingency and frivolous function of the *Würfelspiel* illustrated how unpredictable, unrepeatable, and yet commutable events can take place both despite and owing to the principles held to account for them, whether mathematical or divine.

As Paula Findlen points out, early modern tensions between the preordained and the spontaneous can be traced back to Pliny the Elder's *Natural History*, in which the limitless possibilities of human physiognomy and the wondrous variety of shellfish and flowers are described in terms of nature's playful desire to amuse herself.³¹ Whereas Renaissance humanists embraced Pliny's attribution of anthropic agency to nature as an imaginative, resourceful, and unpredictable force that sought limitless variety via the play of *lusus naturae*, Jesuits such as Kircher and Gaspar Schott "strove to reveal nature's architecture," as Findlen puts it, by codifying the rules of her games.³² The combinatorial mechanics of the *arca musarithmica* (and the more generalized *organum mathematicum* that succeeded it) bore out Kircher's assertion that "if a natural effect may be produced by art, then in this display nature is taught by art to reveal."³³

The belief that nature's ludic secrets could be exposed by art(ifice) and (dis)simulation acknowledged the etymological roots that *ludus* shares with "illusion," played upon by Kircher's disciple Schott in the prologue to his *Magia universalis* (1657): "Here the theater where art and nature play is exposed to curiosity: but while they play (*ludent*) for the learned, they deceive (*illudent*) the ignorant."³⁴ For Kircher and Schott, nature's whimsical jocularities had to be governed by rational principles: revealing them via mathematical and technological inquiry promised to bring the perceptive observer closer to God's own principles of design, just as Leibniz held that his binary poetics offered insight into the deepest mysteries of creation (*omnibus ex nihilo ducendis sufficit unum*).³⁵

With a hint of pious exasperation, Leibniz noted that games seemed to sharpen the wits when it came to the matter of invention, "since the human spirit shows itself to better advantage in games than in the most serious matters."³⁶ Although combinatorial play unfolded according to simple rules codified by humans,

tracing its ramifications exceeded the mental capacities of even the most learned. Yet it turned out that the uncertainty of such play could itself be quantified in accordance with mathematical principles first ascertained by Christiaan Huygens (*Libellus de ratiociniis in ludo aleae*, 1657) and further developed by Pierre Rémond de Montmort (*Essay d'analyse sur les jeux de hasard*, 1708) and Abraham de Moivre (*The Doctrine of Chances*, 1718).

The calculation of probability was likely of little interest to most players of *Würfelspiele*, presumably children or amateurs enlisted via assurances that no prior mathematical or musical knowledge was required. Nonetheless, a firm grasp of permutational principles was of great value to writers of treatises, designers of musical games, and publishers eager to tout the trillions of possible outcomes that a given text could produce. Throughout the eighteenth century, moreover, algorithmic, combinatorial, and aleatoric procedures were continuously embedded in pedagogical techniques and devices aimed at aspiring professional musicians as well as amateurs, documented by writers including Friederich Erhardt Niedt, Joseph Riepel, Heinrich Christoph Koch, Francesco Geminiani, and Francesco Galeazzi as well as Mizler, Marpurg, and Kirnberger.³⁷ As Neal Zaslaw points out, the same mechanisms were presented in different technical and aesthetic guises, depending on their intended audience and whether their means were more profitably advertised or concealed.³⁸

C.P.E. Bach's *Einfall, einen doppelten Contrapunct in der Octave von sechs Tacten zu machen, ohne die Regeln davon zu wissen* ("Method for producing six bars of invertible counterpoint at the octave without knowledge of the rules thereof," Figures 37 and 38), which Marpurg published in 1757, deliberately obfuscates the combinatorial logic and contrapuntal principles underpinning its musical configuration. As the realizations in Figure 38 (Audio 3) and Example 1 (Audio 4) demonstrate, Bach's *Einfall* ultimately produces invertible counterpoint based on a simple second-species Fuxian schema that is as unexceptionable as it is unexceptional. In order to produce a viable musical result, however, players did not merely pluck numbers from the air or spin a nine-sided top: they were enlisted in a nonlinear process involving reiterative reading, counting, reordering, and writing that Bach contrived to be needlessly—but divertingly—arcane.³⁹ By concealing the note-by-note workings of his paper machinery, Bach fostered the impression that it was a mysteriously autonomous system; at the same time, its cabalistic mechanisms relied on the recruitment of players in various musical capacities. The disposition of the *Einfall* goes to show that even when a ludomusical game seems to depend more on the collusion of chance than on skill, it requires the active participation of players who construct and reflect what its operations signify, whether they involve the quasi-compositional sequencing of Bach's atomized notes into a syntactically coherent order or the subsequent transformation of those concatenated symbols into a stream of sound to be heard by way of performance.

ad Tab. IV.

Musical score for 'Einfall' by C.P.E. Bach, showing six tables (TAB. IV to TAB. VI) of guitar tablature and corresponding musical notation. The score is arranged in three systems of two staves each. The first system (TAB. IV) shows a single staff of tablature with 'x' marks and a single staff of musical notation. The second system (TAB. V) shows two staves of tablature and two staves of musical notation. The third system (TAB. VI) shows two staves of tablature and two staves of musical notation. The tablature uses 'x' to indicate fretted notes and numbers for natural notes.

Der aus den Zahlen: $\left. \begin{array}{l} 3 \quad 1 \quad 5 \quad 2 \quad 7 \quad 9 \\ 8 \quad 4 \quad 6 \quad 1 \quad 2 \quad 3 \end{array} \right\}$
 entstehende doppelte Contrapunct
 in der Octave.

Musical score showing the double counterpoint in the octave. It consists of two staves of musical notation, one in the upper register and one in the lower register, illustrating the relationship between the two parts.

FIGURES 7 & 8. C.P.E. Bach, *Einfall*, einen doppelten Contrapunct in der Octave von sechs Tacten zu machen, ohne die Regeln davon zu wissen, in *Historisch-kritische Beiträge zur Aufnahme der Musik*, ed. Friedrich Wilhelm Marpurg, vol. 3, bk. 2 (Berlin: Gottlieb August Lange, 1757), 177 and 181.

AUDIO 3. Marpurg's realization of Bach's *Einfall*, performed by Matthew Hall (harpichord after Jacques Germain [1785] by Thomas and Barbara Wolf [2012]).

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5254/luminos.16.7>





Example 1. Another realization of Bach's *Einfall*.

Audio 4. Demonstration of the invertible counterpoint on display in Example 1, performed by Matthew Hall.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.8>



In their different forms, the archival remnants of eighteenth-century *Würfelspiele* bear traces of the ludic dynamics that motivated and issued from their operations, hinting at the unpredictable elements, the multivocal interactions, and the unruly pleasure that can emerge from the arbitrariness of rule-bound aleatoric play. Just as Kirnberger's *Der allezeit fertige Polonoisen- und Menuettencomponist* produced music for pleasure via mathematical ingenuity and Bach's *Einfall* injected an element of levity into the ostensibly serious business of invertible counterpoint, the ambivalent and even ironic tone of pedagogical methods such as Kirnberger's and Galeazzi's called into question the time-honored opposition of the entertaining and the didactic, the popular and the esoteric, the trivial and the learned.⁴⁰ In marked contrast to the traditionally closed feedback loop between master and apprentice, they proposed models by which the spontaneous creation of music could be made accessible as an enterprise for amateurs as well as professionals.⁴¹

The playfulness of *Würfelspiele* might prompt us to question the opposition of mechanical procedures and improvisatory processes in terms of their systemic properties. In Luhmann's terms, a game—like a computer—is an operationally closed system in that its high degree of internal order, articulated according to rules and facilitated by conditions that allow for the efficient transmission of information via strictly defined channels for input and output, comes at the expense of openness to its environment.⁴² With regard to improvised conduct, conversely, the opposite is generally assumed to be the case: the openness of a system to external input and contingency reduces its capacity for self-organization and -regulation. When ludic and musical players are brought into the equation as interactive agents at the interfaces of such systems, however, these distinctions have to be multiplied and redefined within complex and highly ramified networks. As a result, their processing forms a continuum along which all texts and scores can be understood to have prompted the improvisation of ludomusical behavior in relation to particular sets of rules.

From this perspective, the rules governing the playing of games and the construction of counterpoint can be seen to be contiguous with those proposed by René Descartes as regulators of scientific and philosophical thought (*Regulae ad directionem ingenii*, ca. 1619–28). For all their abstraction, and despite Descartes's

own insistence that “the cognitive exercise of the mind” is to be clearly distinguished from “the exercise and disposition of the body” on which artistic practices depend, Ian Hacking follows Foucault in grounding the formulation of such rules in the disciplinary context of monastic *regulae*, whereby the discursive evaluation of behavior is inseparable from the system that inculcates and controls bodily comportment.⁴³ It is in this sense that the generation of counterpoint, first codified by the Cistercian monk Pierre Palmoiseuse in 1336, was at once strictly rule-bound and coeval—even synonymous—with acts of improvised singing and playing.⁴⁴ Whether the laws of the game issued from a contemporaneous papal decree (as Rob C. Wegman has suggested), were built into algorithms shared among musicians (as Peter Schubert has plausibly demonstrated), or were reverse-engineered from Palestrinian praxis (as Fux claimed to have done), they compelled musicians collectively to maneuver within their exacting limits.⁴⁵ In so doing, however, such diktats exposed their own arbitrariness, posing the question of the means by which the binding power of their own legality could be ratified and thereby raising the possibility—or, in the case of undocumented extemporization, the virtual inevitability—of transgression.⁴⁶

While the concatenated letters of laws enumerate them in serial order, their performative force issues from the fact that some form descriptions while others constitute prescriptions. Rules exhibit and depend upon hierarchical distinctions between those who make, enforce, follow, and break them. At the same time, these distinctions distinguish principle from instance, concept from event, and—perhaps most tellingly—the generic from the specific. Throughout the eighteenth century, the root-and-branch classification and ordering of hierarchies became standardized, owing in large part to the taxonomical nomenclature popularized by Carl Linnaeus’s *Systema naturae* (1735–68), which divided the natural world into kingdoms, orders, classes, genera, and species. In the musical world, such concepts had informed the definition and naming of Fux’s five “species” of counterpoint as well as the codification of the rules according to which each could be identified and produced.⁴⁷

The formation and application of rules thus rely on systematic distinctions between syntax and vocabulary, figure and ground, relations and symbols, functions and data. Swift’s Literary Engine is laughable precisely insofar as it ignores these distinctions and instead processes all information that enters the system as equally (in)significant.⁴⁸ On the page, the appearance of C.P.E. Bach’s *Einfall* was carefully contrived to give the same impression, but the algorithmic rules that players must follow reveal that its linear chaos conceals the same type of tabular order as that coordinated by the *Würfelspiele* of Kirnberger (Figure 39) and those who followed in his ludic footsteps.

Tables collect and classify information according to its functions, transforming a one-dimensional stream of data into a two-dimensional mapping of its attributes.⁴⁹ In representing a particular class of musical object, a tabular row or column in a *Würfelspiel* can be read collectively to determine both the constancy and variability of its elements, allowing the analytically-minded observer to

Tabelle der Würfe zu Polonoisen.

Zum ersten Theile.

mit einem Würfel	1	2	3	4	5	6					
mit zwey Würfeln	2	3	4	5	6	7	8	9	10	11	12
1 Wurf	70	10	42	62	44	72	114	123	131	138	144
2 " "	34	24	6	8	56	30	112	116	147	151	153
3 " "	68	50	60	36	40	4	126	137	143	118	146
4 " "	18	46	2	12	79	28	87	110	113	124	128
5 " "	32	14	52	16	48	22	89	91	101	141	150
6 " "	58	26	66	38	54	64	88	98	115	127	154

Figure 39. Johann Philipp Kirnberger, *Der allezeit fertige Polonoisen- und Menuettencompontist* (Berlin: George Ludewig Winter, 1757), 7. The numbers populating the first two rows refer to the total produced by the player's dice-roll; the contents of the subsequent rows index the 154 musical fragments from which the fourteen-measure-long polonaise is assembled. (This table accounts for the first six measures.)

distinguish between structural and ornamental components by reconstructing the logic obscured by the juxtaposition of notated fragments on the page. The information arrayed in such tables thus encoded a relation between accident and design, revealing the reciprocity of improvisatory and analytical criteria. As Carl Czerny put it to his fititious pupil Miss Cecilia, “you know that all music may be reduced to simple chords. Just so, simple chords conversely serve as the ground-work on which to invent and play all sorts of melodies, passages, skips, embellishments, &c.”⁵⁰

Neither the politesse of Czerny's letters to Miss Cecilia, “a talented and well-educated girl of about twelve years old” nor his lengthy treatise on extemporization (which contains a plethora of nominally “improvised” scores, the means of production of which must be taken as read) details the laborious conceptual, oral, kinesthetic, and material processes by which improvisatory skills were professionally imparted and acquired.⁵¹ By Czerny's day, however, this reciprocal relationship had been painstakingly performed at the keyboard for centuries. An extended passage from Niedt's *Handleitung zur Variation* (1706) could have led Miss Cecilia through the process by which music could be improvised, composed, or tabulated. After enumerating dozens of ways to “make fancy and embellish” every class of rising and falling interval, Niedt presented a bass (out)line that plots a sharpening arc around the circle of fifths (Gjerdingen's *monte*

§ 10, N. 17, § 17, N. 11, § 10, N. 8, § 16, N. 10, § 17, N. 8.

& N. 12, § 9, N. 11.

Wolte man solchen Bass in Sprünge haben/ könnte so gesetzt werden.

§ 10, N. 13, § 17, N. 27, § 10, N. 19, § 17, N. 21.

§ 17, N. 15, & 11, § 9, N. 19.

FIGURE 40 & 41. Bass line and two elaborations thereof from Friederich Erhardt Niedt, *Handleitung zur Variation*, chap. 3 (*The Musical Guide*, 88–90). The numbers underneath the staff refer to the intervallic embellishments enumerated in the preceding chapter.

Audio 5. Niedt's bass line and elaborations from Figures 40 and 41, performed by Matthew Hall.



To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/huminos.16.9>

romanesca schema) before cadentially zeroing back in on the tonic (Figure 40).⁵² Niedt proceeded to show how his ornamental techniques could be combined to animate the bass line via countless figurative, stylistic, metrical, registral, and even dynamic variations (Figure 41, Audio 5).⁵³ He accomplished this by stringing together figures drawn seemingly at random from his freshly stocked inventory of intervallic diminutions—a process commensurate with (and perhaps even inspired by) the process of selecting and concatenating the movable type through which it was made legible.⁵⁴

Makers of *Würfelspiele* followed the same process, defining intervallic, harmonic, and metrical functions before enumerating the interchangeable figures and patterns by which they could be fulfilled. In contrast to Niedt's compendious



Figure 42. Francesco Geminiani, *Guida armonica (Dictionaire harmonique)* (Amsterdam: Geminiani, 1756), 1. Users select at random from the first five notes, each of which indicates the page to which they should subsequently refer.

paper trail, however, wordless tables covered their tracks and created the potential for players' ludic involvement via the presentation of arbitrary choices to make and the contrivance of "unnecessary obstacles," however trivial they might be, to be overcome.⁵⁵

In his *Guida armonica*, first published in Amsterdam as the *Dictionaire harmonique* (Figure 42, 1756), Geminiani aimed for a happy medium between Niedt's work ethic and the *Spieltrieb* of *Würfelspiele*. In the preface, he lauded the virtues of novelty, variety, and entertainment, and his instructions to the reader presume ignorance of the most rudimentary of notational principles. That notwithstanding, the *Guida* enables the concatenation of figured bass lines outlining sequences of phrases of greater harmonic and contrapuntal sophistication than Niedt's rough-and-ready succession of root-position triads. After choosing a starting note, Geminiani's reader is directed to

observe the Number under that Note, and [to] turn to the Page marked with the same Number; there you will find several Passages beginning with the same Note . . . ; choose any one of those Passages . . . , observe the Number at the end of it, and turn to the Page marked with the same Number . . . And thus proceed from Passage to Passage to what length you please.⁵⁶

Once the adventure has been chosen and a bass line assembled, however, players must rely on their own skills to transform its contours and figures into full-fledged music. Geminiani had studied with Alessandro Scarlatti and led the opera orchestra in Naples: to such an accomplished *partimentista*, the means of realizing such a bass line would have been self-evident. His British readers were clearly in need of further assistance, however, which he felt obliged to provide in a supplement to

the *Guida* published the following year. As Klotz notes, Hayes remained skeptical of Geminiani's "Mechanical Method," while Burney recapitulated Hayes's own skewering of Gunn by comparing it to "a kind of mill, in which good Music was to be ground with little trouble and no genius; as good sense and science by the Laputan machine, in Gulliver's Travels."⁵⁷ Neither critic seems fully to have grasped the extent to which the player remained responsible for inventing the music that unfolded above the bass line, whether performed on the violin or by the right hand at the keyboard. As Niedt wrote of the practice of thoroughbass, "the left hand plays the prescribed notes, while the right hand strikes consonances and dissonances, so that this results in a well sounding *Harmonie* for the Honour of God and the permissible delight of the soul."⁵⁸ For both Niedt and Geminiani, the fact that the bass line could be determined by aleatoric means was balanced by the implication that its fixity formed a constraint against which melody and harmony could freely emerge at players' hands.

In their various ways, texts such as Niedt's *Handleitung*, Geminiani's *Guida*, Michel Corrette's *Prototypes contenant des leçons d'accompagnement* (1754), and Riepel's *Anfangsgründe zur musicalischen Setzkunst* (1752–68) diverged from the primarily speculative mode of traditional theoretical treatises.⁵⁹ At oblique angles to the epistemological quest for acoustical and cosmological laws, their rules were presented as heuristic, concrete, and procedural: they aimed not merely to transmit information and to confer knowledge, but to tell musicians what to *do*, stimulating the imagination while guiding the body and building the disciplinary framework necessary for the production of well-turned musical handicraft. As the title of Riepel's *Grundregeln zur Tonordnung* makes clear, these texts are procedural in that they consist of ground rules for the ordering and concatenation of musical material according to a combinatorial epistemology. For his part, Niedt sought to provide a mnemotechnical resource for the aspiring professional musician; he anticipated that his exhaustive list of embellishments would be memorized, their stylistic features (*Manieren*) categorized, and their permutational principles internalized, enabling the generation of music across a wide range of idioms—from preludes to chaconnes and sarabandes to giges—whenever and wherever the need arose. Geminiani, conversely, envisaged his *Guida* as an external catalog of a musical lexicon: since "Memory cannot always be depended upon, the Work is so disposed, that the student . . . may recur to it as a Dictionary."⁶⁰

Whether framed in terms of work or play, duty or pleasure, such texts depart from the literary model bemoaned by Socrates, who complained that the written word was overdetermined as a storage medium: "you might think [written words] spoke as if they had intelligence, but if you question them, wishing to know about their sayings, they always say only one and the same thing."⁶¹ The same could not be said of the virtually limitless possibilities encoded by the 2,236 excerpts compiled in Geminiani's encyclopedic treatise, the final page of which bears the

designation “Fine senza Fine.” As prompts rather than paragons, Geminiani’s and Niedt’s musical and numerical figures testify to the possibility—indeed, the necessity—of transmitting information without prescribing it, of writing notes that denote more than a single sonority. Just as the ludic properties of dice depend upon their having no memory, the arbitrary ordering of Niedt’s mnemotechnical numerals reveals that his means of stringing together musical figures must be remembered only in order to be forgotten.⁶²

The question of whether the emergence of such music is better described in terms of composition, extemporization, or unconscious automation seems not to have come to the fore in the eighteenth century. Rather than delving into musical poetics or evaluating the sonic results of their methods, Niedt and Riepel were primarily and pragmatically concerned with the cognitive and manual contingencies under which music could be made and played. The forms of knowledge they conveyed were not so much propositional or linguistic as “implicit and embodied,” manifested and legitimated “through the handling of objects and instruments,” as Sybille Krämer and Horst Bredekamp put it.⁶³ From this perspective, the difference between the earnestness of pedagogical handbooks and the frivolity of *Würfelspiele* has to do not with their analogous means of accessing, selecting, and processing data, but rather with the distribution of these tasks across a musical ecosystem that incorporated texts, players, and instruments. Whereas Niedt and Riepel sought to inculcate all necessary capacities within the mind and body of the musician, *Würfelspiele* outsourced the storage and organization of data to the textual materials and rules of the game itself. Kirnberger’s *allezeit fertige Polonoisen- und Menuettencomponist* (“The ever-ready composer of polonaises and minuets”) assumes the function of the aspiring *Kapellmeister* addressed by Niedt: limited to only two dance types, Kirnberger’s paper composer atones for its lack of variety by its state of perpetual availability. Similarly, the full title of C.P.E. Bach’s *Einfall* makes it clear that its own rules supplant those governing the production of invertible counterpoint by assuring players that they will be relieved of the burden of such knowledge. Rather than charging humans with the imposition of musical order via the hypotactic hierarchical and combinatorial (re)composition of its fundamental components, dice games demand the opposite: players become agents of noisy disorder by injecting random numbers that they have generated, a seemingly simple task that is notoriously difficult to perform within “closed” systems, the integrity of which relies on their very reliability.

From ancient dice to the contrivance of roulette, the history of the material properties and manifestations on which *alea* depends can be read as a series of attempts to establish systemic premises from which outcomes can be derived that are commensurate with and yet indeterminable by those premises. Within such systems, complex phenomena can issue from (and be represented via) simple forms, whether they involve the motion of temporarily airborne cubes and

spheres within a circumscribed space or the transmission of electrical impulses across neural networks that leads to the depression of a particular key. In this context, distinctions between “closed” and “open” systems and between structural and ornamental elements become matters of degree rather than kind. Establishing the limits of a system, whether by the imposition of rules or by the fabrication of material boundaries, can open up unforeseen affordances even as it realizes envisaged constraints. As discussed in Key 1, the ludic concept of the magic circle can help clarify the circumscriptive ambiguities of locations, objects, and systems that are cordoned off from the world even as they remain part of it.⁶⁴ Analogously, we might place Kircher’s *arca musarithmica* alongside the obfuscatory gambits of C.P.E. Bach’s *Einfall* and the tabular indeterminacy of Kirnberger’s paper machine as ludomusical systems that are operationally closed but concomitantly open to communication with their psychic and social counterparts.

For all the mechanicity of such systems, their input, output, and processing of information depend on human in(ter)vention. Niedt’s *Handleitung* makes this dependency most explicit insofar as its very title describes it as a “manual” that both guides and responds to the hand turning its pages and realizing its content at the keyboard. Along the lines of inquiry drawn in Key 2–3, this suggests how we might think of the keyboard itself as the interface of a ludomusical system that negotiates between bodies, minds, objects, and sonic phenomena. The keyboard is akin to a table or matrix to the extent that it arrays classes of pitches across multiple spatial dimensions. Accessed in parallel as well as serially, it affords permutational possibilities that can represent both data and process, configurations of memory and the execution of code.⁶⁵

While the digit operates both as an agent of calculation and as a generative principle at the keyboard, the consequences of digital procedures cannot be wholly determined in advance, especially in relation to extemporization. No matter how schematic and mathematical its underpinnings might be, improvisation at the keyboard relies on a type of embodied knowledge, produced cognitively, socially, and technologically, that evades rationalization and allows for the improviser to surprise even herself. As Czerny remarked to Miss Cecilia, “extemporizing possesses this singular and puzzling property, that reflection and attention are of scarcely any service in the matter. We must leave nearly everything to the fingers and to chance”—to the digital and to the aleatoric, in other words.⁶⁶ We might consider this not only in the context of Leibniz’s acknowledgment that ludic pursuits could display the mind’s inventive powers to better advantage than loftier matters, but also in light of his aphoristic dictum that music “is a hidden arithmetic exercise of the soul, which does not know that it is counting.”⁶⁷

In their different ways, Leibniz, Niedt, and Czerny drew on a conception of contingency that allowed improvisation, whether performed via the playing of *Würfelspiele* or the maneuvers of well-drilled fingers at the keyboard, to be

understood as at once calculable and unforeseeable, obligatory and implausible, mundane and fantastical, mechanical and handmade. *Data-driven models of ludomusical emergence bypassed literary modes of representation; at the same time, their combinatorial principles and hierarchical formalism were inflected by sensuous and conceptual considerations that defied symbolic reduction to and by digits alone.*⁶⁸ From the embodied gestures that lurk behind Niedt's musical figures to the dynamic nuances that Czerny imagined to flow at the "will and pleasure" of Miss Cecilia's fingers, manual operations and aleatoric selections were primed and modulated to ensure that the audible results could participate in social discourse.⁶⁹

3-2 PANTOMIMES AND PARTIMENTI

Technically as well as socially, the emergence and development of improvisatory techniques at the keyboard can be understood as both digital and analogical, algorithmic and aleatoric, systematic and chaotic. But what of the historical conditions under which extemporization became thematized as such toward the end of the eighteenth century? Within and beyond musical contexts, play played a central role in the staging of Enlightenment culture. *From the dice game to the fantasia, ludomusical modes of behavior were framed by a fascination with (un)likelihood that was both economic and erotic, philosophical and trivial, whimsically capricious and grounded in quotidian reality.*⁷⁰ As the divertimenti and bagatelles written there imply, the Vienna in which Mozart and Beethoven played and worked provided a variety of ludic diversions and pastimes that prompted analogous instrumental endeavors. Construed both as scripts for playful behavior and as the results thereof, keyboard scores tallied by both composers are subjected to a degree of play-by-play analysis in Key 4. For now, it must suffice to note that the environment from which these scores issued reflects a ludic sensibility that informed (and took the form of) phenomena as ostensibly far-flung as amorous rivalry and exhibitions of ballistic skill.

Mozart's enthusiasm for ludic pursuits, at once perpetuated and distorted by the historiographical trope of the "immortal child," has been comprehensively documented by Günther G. Bauer.⁷¹ From the skittle alley, shooting gallery, and billiard table to the ballroom, Mozart was typical of his day insofar as he delighted in the *agōn* and *ilinx* of bodies in motion: he produced music connected to the activities that took place in all four locations.⁷² As well as dabbling with the musical *alea* of *Würfelspiele*, he was also a keen player of cards, which he seems to have shuffled and dealt in hope of gaining both pecuniary advantage and oracular glimpses into the future.⁷³ But late-eighteenth-century play was more than a set of activities and types of behavior: it was a social mode that embraced the pleasure of uncertainty via dialogue and flirtation, wit and strategy, skill and rivalry, disguise and dissimulation, good fortune and bad luck. In the words of a Viennese

games manual published in 1756, the year of Mozart's birth, this was "The Century of Freethinkers, Journals, and Games."⁷⁴ From Jean-Honoré Fragonard's erotic depictions of diversionary pastimes to Marivaux's theatrical games of love, chance, disguise, and deception (the likes of which were adapted by Lorenzo Da Ponte and Mozart in *Così fan tutte*), the ludic dynamics of role-play informed and enlivened late-eighteenth-century culture writ large.⁷⁵ Accordingly, *mimicry* was integral to the mechanisms for generating and performing unpredictable acts via the manner in which they were staged. In musical terms, the improvisatory notions of (im)probability and *mimicry* connect the loftiest flights of fancy at the keyboard to the motley traditions embodied by the players of the *commedia dell'arte* on which Marivaux drew. Notably, in many ways unnotatably, Mozart's role-play spanned this entire sociomusical spectrum. To account for its unwritten elements, it will be necessary to loop back and retread the historical ground covered in Key 3–1 from an Italian angle that will ultimately intersect with the systematic methods of generating unforeseeable content documented elsewhere in Europe.

From the sixteenth century onward, the itinerant players of *commedia dell'arte* troupes extemporized, modeled, and parodied various forms of sociality by framing the uncertainty of outcomes within the boundaries circumscribed by conventions and archetypes as well as by theatrical spaces from the piazza to the opera house.⁷⁶ Typical troupes consisted of ten to twelve performers, sometimes members of an extended family, each of whom would spend years studying and inhabiting a character's bearing, gestural repertoire, and patterns of speech. In collaboration with its counterparts, each character was associated with a particular set of *lazzi*, *burle*, and *congetti* (slapstick routines, gags, and repartee). To the extent that acquiring the dexterity and performing the prodigious feats of memory demanded by improvisation *alla commedia dell'arte* entailed a lifelong commitment, the dialogical skills, contrapuntal expertise, and ludic sensibilities displayed by its practitioners were comparable to—and sometimes inseparable from—those manifested by the most accomplished musical improvisers, as Gjerdingen, Sanguinetti, Georg Knepler, and Shawn Marie Keener have pointed out.⁷⁷ In both cases, extemporized high-wire acts were performed over the safety net provided not only by intensive training, but also by the subjunctive mood of play in its multiple ludic and theatrical senses.⁷⁸

Alongside other European centers, Vienna played host to itinerant troupes of Italian actors throughout the eighteenth century, as a result of which the stock characters of the *commedia dell'arte* became syncretically fused with local traditions. In particular, the figure of Harlequin closely shadowed those of the roguish Hanswurst, a scatological Salzburger made (in)famous by the actor Joseph Anton Stranitzky who infiltrated all manner of theatrical and musical productions under various guises, and Bernardon, played by Joseph Felix von Kurz, who enlisted the young Haydn to provide musical accompaniment for his pantomimic antics.⁷⁹ But just as literati such as Johann Christoph Gottsched complained that Hanswurst lowered the

theatrical tone and dragged down playwrights' loftier ambitions, so mid-century musical critics such as Johann Adam Hiller and Carl Ludwig Junker complained that the Hanswurstian escapades of Haydn and his confreres had turned Viennese music into a laughing stock.⁸⁰ After a series of restrictions failed to have the desired effect, Maria Theresa banned extemporized theater in 1769; for the influential Joseph von Sonnenfels, who was appointed as censor the following year, this was as much an aesthetic as a moral and political matter.⁸¹ Under Joseph II, Hanswurst and his companions were permanently exiled by the strict proscription of all theatrical improvisation and buffoonery, which had a major impact on manifestations of the *commedia dell'arte* tradition in dramatic, literary, and operatic forms.⁸²

Another scatological Salzburger, who went so far as to use Hanswurst as an occasional pseudonym, openly professed his delight in the *commedia dell'arte* and its Germanophone counterpart, even if—or perhaps precisely because—they had acquired a decidedly subcultural status by 1783.⁸³ In January, Mozart asked his father Leopold to send a Harlequin costume from Salzburg to Vienna so that he could wear it to public balls during that year's Viennese carnival season.⁸⁴ In a subsequent letter, Mozart adopted a tone of secrecy and intrigue that at once bespoke and described a *commedia dell'arte*-style scheme to form an ad hoc company of masqueraders to “perform a small Pantomime.”⁸⁵ Less than a month later, this pantomime was staged during the intermission of a masked ball in the Redoutensaal at the Hofburg Palace, whereupon Mozart reported that he and his friends had “played quite charmingly.”⁸⁶ The production starred Mozart as Arlecchino (Harlequin) and also featured his sister-in-law Aloisia Lange as Colombine, her husband Joseph as Pierò (Pierrot), the painter Josef Grassi as *il dottore*, and an old dancing master, Merk, who played Pantalone and coordinated the ensemble.

Although Mozart wrote fifteen numbers for string quartet, only the first violin part survives, and even that is incomplete; the “simple rhymed couplets” written by Johann Heinrich Friedrich Müller no longer survive.⁸⁷ Dramatically, all that remains is a discontinuous series of terse stage directions in the violin part, similar in form and function to the *canovaccio* that a *commedia dell'arte* troupe would pin up backstage as an aide-mémoire for the sequence of their *lazzi*.⁸⁸ But while the pantomime's fragmentary textual status poses a virtually insurmountable philological problem, it also exposes the fact that *all* musical texts are fragmentary when it comes to the task of their reanimation, especially over large historical and cultural distances.⁸⁹ As Elisabeth Le Guin and Tom Beghin have demonstrated with regard to Luigi Boccherini and Haydn, respectively, embodied experience not only is integral to the making sense of textual evidence, but can also constitute a type of musical evidence to be reverse-engineered or recreated in its own right.⁹⁰ Performing and improvising musicians constantly negotiate between codified forms of knowledge, whether retrieved from physical media or stored as habit and memory, and the ever-changing exigencies of the present moment. Music's

sensuous presence has a history, just as its history is relayed via the senses. But how might the contingency of musical presence be restored once it has receded into the remote past, when the limitless possibilities of what might yet be have either vanished or hardened into the ossified remains of what was? In other words, how can the immediacy of improvisation be historically mediated?

Ethnomusicologists have long considered how musical skills, knowledge, and experience can be transmitted across temporal and spatial networks of pedagogues, performers, and audiences. In particular, jazz scholars—chief among them Paul F. Berliner and Ingrid Monson—have shown how such networks operate both vertically (as is the case with pedagogical techniques and materials passed from one generation to the next) and horizontally (when nonhierarchical interactions occur within a group to the extent that, in Monson's words, "an ever-changing community of musicians [functions] as a learning environment").⁹¹ These types of networks are well suited to the distribution and acquisition of improvisatory skills among teachers, students, and peers. Professional jazz musicians often exchange musical ideas in terms that might seem frustratingly imprecise to noninitiates, but their laconic interaction masks the substantial amount of knowledge and embodied experience that is conveyed through means other than words or notes.⁹² Of course, notation is still important to many jazz musicians insofar as it provides a medium through which the "standard" repertoire circulates. Tellingly, however, jazz musicians tend to conceive of written music not as a "score" that tallies musical instructions, but rather as a "chart" that maps out musical space to be navigated in the course of performance.

Taking salient idiomatic, historical, cultural, and medial differences into account, it might be supposed that analogous networks must have existed wherever and whenever improvisation has flourished.⁹³ Departing from this premise, Gjerdingen and Sanguinetti have identified the major nodes of the network that informed the training of most eminent eighteenth-century composers, many of whom were also storied improvisers.⁹⁴ Centered on Naples, this network of conservatories, courts, theaters, and churches sustained and conveyed music (and musicians) across the whole of Europe. In particular, Gjerdingen has focused on the political, social, psychological, and cognitive forces that transformed Neapolitan *conservatori* into sites renowned throughout Europe for their distinctive methods of musical training and enculturation, producing what might be synonymously conceived as *galant* court music and a particular form of Neapolitan vernacular music. The cramped conditions of most *conservatori*, many residents of which were orphans, meant that students would have acquired musical experience and expertise through (in)voluntary collaboration with their peers as well as through individual study.⁹⁵ In terms of socioeconomic profile, the experience of Neapolitan student musicians in the eighteenth century was perhaps closer to that of aspiring jazz musicians in Harlem in the 1940s than it was to instrumentalists growing up in the rarefied world of "classical" music today.

Similarly, the reliance on shorthand and the deceptive simplicity that characterize the written materials used in *conservatori* place them closer to jazz musicians' charts than to normative scores. The primary pedagogical means by which improvisatory and contrapuntal skill could be inculcated was the *partimento*, which typically took the form of music sketched on a single staff that held a wide range of possibilities made identifiable and distinguishable via performers' skill, memory, and ingenuity, acquired and reinforced over years of intensive training.⁹⁶ It was by virtue of such training that Geminiani could assume that even an aleatorically generated bass line must contain all the necessary information for its successful melodic and harmonic realization.⁹⁷

As Gjerdingen and Sanguinetti both note, *partimenti* are analogous to *zibaldoni*, which complemented *canovacci* to form the textual media of the *commedia dell'arte*.⁹⁸ *Zibaldoni* were hand-copied notebooks that contained the *lazzi*, *burle*, and *concetti* of every actor in a *commedia dell'arte* troupe. Just as sophisticated musical phrases can be extrapolated from a bass line and concatenated from the syntax and lexicon of opening gambits, means of spinning out the action (*movimenti*), and closing formulae (*clausulae*), so *zibaldoni* contained the shorthand by which a *canovaccio* could be enacted via extemporized interplay between the stock characters of the *commedia dell'arte*.⁹⁹ As Kenneth and Laura Richards put it, performing a play *all'improvviso* "was a process of collaborative 'making,' the success of which was rooted in virtuoso skills and the players' familiarity" with one another.¹⁰⁰ In the words of Évariste Gherardi, a renowned Harlequin who graced Parisian stages at the turn of the eighteenth century,

Italian actors do not memorize texts; when performing a play, it is enough for them to learn of its subject a moment before they take to the stage. . . . A good Italian *comédien* plays more on the strength of his imagination than on his memory; in the midst of play, he composes everything he says in real time. . . . He matches his own words and actions to those of his onstage partner, each playing off the other so well as to make everyone believe that the two must have planned it all out in advance.¹⁰¹

Simultaneously imposing and facilitating the dialogical basis on which the action of the *commedia dell'arte* proceeds, Gherardi's partner afforded and constrained opportunities for extemporization within a given scenario and relational dynamic, both of which were shaped by historical as well as cultural factors.¹⁰² As Angela Esterhammer observes, "the improvisation of a character's dialogue and action is delimited by the disposition that has accrued to that character from generations of earlier actors and performances."¹⁰³

When realizing a *partimento* or *solfeggio* at the keyboard, a similar logic applies, whether two pairs of hands are involved or only one.¹⁰⁴ The bass line provides the basis of a *canovaccio* that prompts the player's musical partner, the right hand, or (in the case of a *solfeggio*) the voice to engage and complement it in a manner at once congruent and unexpected by devising counterpoint that just so happens to accord with the prevailing theoretical and cultural *regole*. Like the walls of a

squash court, such musical delineations foster collaborative and competitive collusion both despite and owing to their rigidity.

This coordinated complementarity, at once scripted and improvised, evokes Niedt's description of the process by which thoroughbass produces a "well sounding *Harmonie* for the Honour of God and the permissible delight of the soul."¹⁰⁵ On the one hand, it gestures toward an extemporaneous and contemporaneous enterprise shared by German and Austrian exponents of thoroughbass and *partiturae* (such as Niedt, Johann David Heinichen, Matthäus Gugl, and Mattheson), French *clavecinistes*, and Italian *partimentisti*; on the other, it identifies elements that were easily lost and found in musical, linguistic, and cultural translation, creating ambiguities and misunderstandings that persisted from Gherardi and Niedt's day to Goethe and Fétis's.¹⁰⁶ While Niedt provided anecdotal evidence of Teutonic defensiveness in the face of spontaneous Italian virtuosity, Goethe's long-standing fascination with improvisation *alla commedia dell'arte* is visible throughout the convoluted genesis of *Wilhelm Meisters Lehrjahre* (1795–96), even if he ultimately concluded that it could not be successfully adapted to (and by) German theatrical culture and politics.¹⁰⁷ For his part, Fétis presented the *partimento* tradition as a fossilized set of rules that was inimical to modern harmonic thought and the exercising of compositional genius.¹⁰⁸

That notwithstanding, the young but worldly Mozart had little trouble combining his ardor for the profanities of the *commedia dell'arte* with respect for customs that regulated spontaneous musical behavior in liturgical contexts. He encountered the Salzburgian *partitura* tradition via Johann Ernst Eberlin, whose students learned how "to improvise variations and embellishments of small musical units" at the organ.¹⁰⁹ Mozart was preternaturally adept at navigating diverse compositional styles, registers, and even topography on the fly, a skill that came to the fore whenever he was seated at an unfamiliar instrument: indeed, he first raised the matter of the Harlequin costume to his father on the heels of a reference to unscripted exploits at the keyboard.¹¹⁰ Moreover, as Haydn had proved to Kurz-Bernardon and as Beghin demonstrates by way of the former's capriccio "Acht Sauschneider müssen seyn," Hob. XVII:1 (1765), the slapstick comedy of Hanswurstian pantomime could itself be played out at the keyboard—perhaps all the better to avoid the risk of censure (or even censorship).¹¹¹ Read in this light, the fragmentary letters and notes that constitute the textual evidence of Mozart's pantomime and the marginal circumstances of its performance (which took place during a half-hour intermission) suggest that the wordless gestures of pantomime and the mimetic gestures of instrumental music could join forces under the rubric of play to challenge and elude the claims of artistic and political authority.

Although—indeed, because—it was not conceived as such, approaching the surviving first violin part of Mozart's pantomime music as an upside-down *partimento* makes it intelligible as a set of rules for play rather than as the mutilated remains of a lost work.¹¹² Analogously, its *canovaccio* might be conceived less as "a little heap of ashes left from a great and spectacular fire," as Pierre Duchartre dismissed such scenarios, than as "a sophisticated and detailed dramaturgical

machine,” as Robert Henke has more recently recast them.¹¹³ Mozart’s music provides clues not only to the reconstitution of its missing parts, but also to the gestural vocabulary deployed by each character in the realization of the *canovaccio*. It does so by way of metrical, rhythmic, harmonic, and melodic features, many of which are mimetically grounded in specific dance idioms.

Diverting critical attention away from the rhetorical traditions of Koch, Sulzer, and other representatives of “the Lutheran *musica poetica*” whose methods and conclusions he considers to be outmoded (not to mention overdetermined by their own literary format), Stephen Rumph stresses that “late eighteenth-century music takes shape around the choreographic symmetries of the body . . . at every level, from the smallest phrase to the grandest sonata form.”¹¹⁴ In their different ways, Niedt’s *Handleitung* and Kirnberger’s *Würfelspiel* make clear that each dance form was associated with a gestural syntax, a repertoire of “dynamic processes analogized through music’s patterned sound,” as Lawrence M. Zbikowski phrases it, based on reciprocal yet arbitrary gestural symmetry.¹¹⁵ The movement of eighteenth-century dancers was itself represented by *Würfelspiel*-like figures, tables, and aleatoric permutations of temporal and musical sequences.¹¹⁶ Furthermore, the compulsive entrainment of these rhythmic profiles was wordlessly freighted with the premises and implications of social differentiation and stratification. On the most basic level, noble personages moved slowly and deliberately while the motion of commoners was frenetic and abandoned: this much is evident from the storied mechanical theater at the Hellbrunn Palace (1752), which features 141 automated figures from all walks of life whose social rank can be inversely correlated with their rate of motion.¹¹⁷

Beyond sheer tempo, the senses in which “ways of moving both reveal and infuse ways of being,” as Wye Jamison Allanbrook put it, emerge from the metrical characteristics of specific dance forms, from the hauteur of the courtly sarabande to the breathless *ilinx* of *Deutscher-Walzer*.¹¹⁸ By identifying and distinguishing the musical strategies according to which the rhythmic movement of human bodies became coordinable, Allanbrook took an Aristotelian line on the primacy of human action and the mimetic means of its representation: as she pithily summed it up, “motion is character” in musical as well as moral terms.¹¹⁹ Insofar as society could be imagined or construed to be ordered by models and codes of behavior that were transmitted and recreated via processes of imitation, mimesis at once proposed and provided evidence that the world in all its bustling diversity could be “held in common.”¹²⁰ In musical terms, the mimetic modulation of gestures and connotations associated with different dance forms has been associated with the proliferation of topical idioms as enumerated by Ratner, Allanbrook, and Kofi Agawu.¹²¹ From the pastoral hillside to the battlefield and the church to the harem, topical parameters set the tone and the scene for encounters that could be staged both musically and dramatically.

At the midpoint of the eighteenth century, such modes of musical signification were by no means new, but the rate of topical change accelerated in step with the comic imbroglios of Giovanni Battista Pergolesi’s *La serva padrona* and its fellow

commediated *intermezzi*, which took Paris by storm.¹²² The dialogical wit, rhythmic verve, and textural clarity of this Neapolitan style were wholly in keeping with the *partimento* tradition. As borne out by the fractious *querelle des bouffons*, its implications were radical: not only did such *intermezzi* make a mockery of Aristotelian unity of affect, but they threatened to unleash the political chaos that Plato (and Louis XIV) had feared would ensue were mimesis allowed to run wild.¹²³ A citizen who imitates multiple models falls prey to the madness of “pantomimesis,” a state vividly conveyed by Diderot’s memorable portrayal of the antics of Rameau’s nephew, swept away by the unstoppable flow of the heterogeneous phenomena he imitates and thus dispossessed of his reason.¹²⁴ As Hans Ulrich Gumbrecht reads it, the performance of the nephew’s pantomime entails a passing “from a digital to an analog mode of communication: he copies meanings with physical gestures rather than representing them with words.”¹²⁵ If such pantomimesis were itself to be mimicked, his personal undoing would herald the dissolution of society into a state of anomie.

It was in the face of such risks that the *lieto fine* (“happy ending”) became de rigueur as a means of containing centrifugal political dynamics and maintaining the integrity of the stratified social order.¹²⁶ Additionally, the theatricality of mimesis (and vice versa) indicates how the notion of play could frame comedic performance in a way that allows the combination of subversive elements to unfold in a subjunctive mood that could embrace the unexpected with the understanding that contingency is itself contingent. Writing on theatrical comedy at the turn of the nineteenth century, Adam Müller observed that the pleasure of play lay in the finite gap between the self and the external forces to which it temporarily surrendered:

In all activities that humans oppose to the serious and necessary courses of their lives and that they call play, we make room for coincidences, for destiny, in short for a certain unknown power: with this freely acknowledged coincidence, with this self-created mystery, man competes when playing; and it creates a certain pleasant tension between the player and this unknown entity, an uplifting series of very different emotions, of hopes and worries, of deception and fulfillment, in which the soul takes pleasure, because it knows that the coincidence with which it plays depends on the soul itself and can be enthroned and demoted at will.¹²⁷

Müller’s ludic formulation brings together unforeseeability (*alea*) and contestation (*agōn*) under the banner of *mimicry*, which is to say mimesis that playfully stages itself. Via this mimetic framing, as Luhmann pointed out, play does not seek to supplant or negate reality, but rather to multiply it.

The figure of Harlequin formed a prime locus of commediated play. His physical brand of comedy, metonymized by his *batacchio* (a literal slapstick), often embroiled him in agonistic conflict; more broadly, it relied on an eloquent gestural vocabulary that was readily legible under the rubric of *mimicry*.¹²⁸ As Figure 43 illustrates, moreover, the whimsy of Harlequin’s striking gestures bespoke the ludic vicissitudes of *alea*, Müller’s “unknown power” of fate and fortune, symbolized



Figure 43. Harlequin with a Bird (Meissen Porcelain Manufactory, 1743). Hard-paste porcelain with overglaze enamels and gilding. Gift of George and Helen Gardiner. Photograph reproduced by permission of the Gardiner Museum, Toronto (G83.1.21).

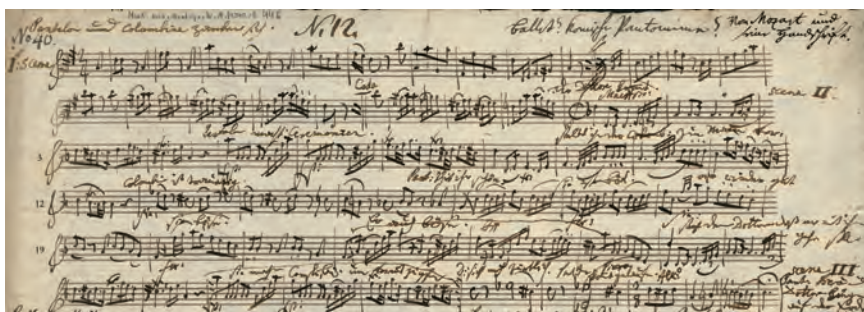


Figure 44. Wolfgang Amadeus Mozart, autograph score of “Musik zu einer Faschingspantomime,” K. 446/416d (1783), scenes 1–2. (“Pantalone and Colombine quarrel. The *dottore* enters. Pantalone does the honors. He introduces Colombine to the *dottore* as her suitor. Colombine is sad. Pantalone tries to cheer her up. She is cross. He again tries to cheer her up. She is still cross. He is also cross. He says to the *dottore* that he is to go with him. They make a fuss of leaving. The *dottore* looks after her tenderly. Pierò comes running.” Translated by Bettina Varwig.) Reproduced by permission of the Staatsbibliothek zu Berlin. CC BY-NC-SA 3.0 DE.

here by the playing cards that adorn his costume and the Papagenian flightiness of his avian accoutrements.¹²⁹ The ludic qualities of the *commedia dell'arte* were derived not only from its rule- and class-based governance, the masked role-play of *mimicry*, and the pleasure taken by actors and audiences in agonistic battles of wits and fists, but also from the uncertainty of *alea*, whether introduced by a flash of inspiration, a momentary mishap, or even a heckler’s caustic interjection.

The notes and letters associated with the second scene of Mozart’s pantomime (Figure 44) choreograph the emergence of comedy from the quicksilver interplay between topic, affect, narrative, and character. As recorded in the surviving violin part, “The *dottore* enters. Pantalone does the honors. He introduces Colombine to the *dottore* as her suitor. Colombine is sad.” From this text alone, the emotive impact of the *dottore*’s designs on Colombine becomes apparent only as the conclusion of a four-stage sequence of events. Musically, however, Colombine’s misery

is immediately foreheard via the minor key and implicit *lamento* bass (outlining a descending Phrygian tetrachord) that darken the *dottore*'s pompous entrance and Frenchified overtures toward her, advanced with characteristic trills and dotted rhythms (mm. 1–4).¹³⁰ Each phrase of the *canovaccio* is complemented by topical musical shifts that flesh out its baldly denotative language, from the accents that at once underline and undermine Pantalone's exaggeratedly ceremonious introductions (mm. 5–6) and the optimism with which he brings the "couple" together (mm. 9–12) to the appoggiaturas that envoice Colombine's Pamina-like sighs of despair (m. 13f).¹³¹ Pantalone tries to drive her toward the F major of the connubial bliss that he envisages for her (and the financial rewards he presumably hopes to reap for himself), but his efforts are rebuffed by Colombine, who firmly tilts the music back toward D minor (mm. 19–25).

In the *commedia dell'arte*, humor was often malicious, conspiratorial, or xenophobic, as is borne out by the dark implications of the sexual economy involving *il dottore*, Pantalone, and Colombine and the unexplained appearance of menacing Turks—the abiding bogeymen of the Viennese cultural imagination.¹³² But just as sophisticated musical phrases could be assembled from the relatively restricted syntax and vocabulary of *partimenti*, so could moments of tenderness and delicate ambiguity arise from the schematically improvised badinage between the pantomime's stock characters and the people who played them. As the actor Simon Callow has pointed out, *commedia dell'arte* masks are as concerned with revelation as with concealment: rather than hiding individuality, the mask makes visible elements within the actor that might otherwise go unseen.¹³³ When Mozart played Harlequin, Harlequin also played Mozart insofar as each shaped and reflected the other. On the one hand, as David P. Schroeder suggests, Mozart's identification with Harlequin plays up to the image of the composer as a character who extricates himself from sticky situations through agility, ingenuity, deception, or sheer audacity—in short, through professional-grade improvisation.¹³⁴ On the other, and in the context of the Viennese carnival season, Mozart's harlequinade revealed him to be no different from countless other revelers who temporarily adopted the *habitus* of rejecting *habitus*, bending the normative rules governing identity, behavior, and the distinction between "performance" and "real life" in predictably unpredictable ways.¹³⁵

As is the case with analogous musical practices, accounts of the decline of the *commedia dell'arte* have been strongly influenced by a Romantic nostalgia for orality that only became conceivable and expressible in literate terms: historical distance is figured in terms of the aporia (sur)rendered by the inability of the written word to capture the evanescence of improvised performance.¹³⁶ The plays and libretti of Carlo Goldoni are thus read not to have praised the *commedia dell'arte* tradition, but to have buried it.¹³⁷ The functions of the written and the spoken word are better understood to have complemented than to have opposed each other, however.¹³⁸ As the etymology of the term implies, a playwright wrought rather than wrote

plays. Rather than seeking to nail oral traditions down to the letter, Goldoni's theatrical contraptions constituted a dramatic overhaul of the *canovaccio's* sophisticated paper machinery, introducing new possibilities for characterization and political nuance. Just as a *canovaccio* did not prohibit the rehearsal and repetition of material that proved popular, so the detail and specificity of Goldoni's texts no more precluded improvisation than did a fully written-out score by Mozart.¹³⁹

From this perspective, it is telling that Mozart evinced no cognitive dissonance when undertaking his own personal operatic reforms, pledging to adapt Goldoni's *Il servitore di due padroni* as a German *Nationaloper* at the same time as devising the *canovaccio* and music for his carnival pantomime.¹⁴⁰ Analogously, it is self-evident that the world of Mozart's mature *opere buffe* is thoroughly grounded in the *commedia dell'arte*, from its broad range of comic registers to its dependence on the finely tuned dynamics of an ensemble cast rather than the star qualities of individuals. The resourceful servant girl, the love-struck youth, the windbag, the sleazy playboy, the put-upon drudge, the resourceful outlaw: almost every musico-dramatic archetype underpinning the subtle characterization of *Le nozze di Figaro*, *Don Giovanni*, and *Così fan tutte* is rooted in the extemporaneous traditions of the *commedia dell'arte*, which informed the mode of performance as much as the typology of characters and their interactions.¹⁴¹

Luigi Bassi, who played the eponymous role at *Don Giovanni's* Prague premiere, recalled that the act 2 finale was "[never sung] the same way twice. We did not keep the time very strictly, but made a joke of it, each time something new, and only taking heed of the orchestra—everything *parlando* and nearly improvised, as Mozart wished it."¹⁴² Bassi's comments reveal how even the elaborate mechanics of full-fledged *opera buffa* incorporated improvisation by refusing to conform to a distinction between "the transitory nature of a performance and the presumed stasis of textual prescription," as Edgar Landgraf frames it.¹⁴³ Even a dramatic increase in the density of textual information does not remove uncertainty or prohibit incursions of the unexpected, but rather relocates them to nontextual dimensions. The care with which Da Ponte and Mozart plotted the comic imbroglio of their operatic finales reveals how improvisation could itself be thematized and staged: as exemplified by the improbable chain of events following Cherubino's autodefensation in *Figaro*, the plot's byzantine mechanisms necessitate desperate improvisation, but allot greater responsibility to the performances of characters than to the charisma of performers.

For Bassi, however, Mozart's role as director could at times supersede his compositional function. In the spirit of Gherardi's harlequinades as well as Mozart's wishes, Bassi's jocular play was not primarily regulated by notes or letters, but by his fellow actors and the real-time sounds of the orchestra. The same could be said of Mozart's role as an instrumental performer in *Die Zauberflöte*, when he mischievously upstaged Papageno (played by

Emanuel Schikaneder) by departing from the glockenspiel part that he had written for Schikaneder to simulate: as a result, the latter acted as though the glockenspiel were playing itself, which (as Mozart observed) amused the gathered observers.¹⁴⁴ For both librettist and composer, the dialogical improvisation of ludomusical *mimicry*—or rather the recursive *mimicry* of *mimicry*—undid the illusion of authorial control while disabusing the audience of the diegetic conceit on which the enterprise of opera relies.

Like the phenomena to which they give rise, loci of improvisatory emergence are subject to change over time. They migrate across ludomusical systems as the ideological and material formations of likelihood and uncertainty. In terms expounded by Keith Johnstone, the solidity of platforms must be considered alongside their propensity to tilt: depending on perspective, a constraint might provide safety or even become charged with liberatory potential.¹⁴⁵ *Würfelspiele*, *partimenti*, and the *commedia dell'arte* generated unforeseeable outcomes from mechanical principles via the play of *alea*; by way of *mimicry*, these processes and consequences were made inhabitable and communicable in the terms of shared embodied experience. With these technosocial factors in mind, we are equipped to inquire more deeply into the composition of systems, from Kircher's *arca musarithmica* to the 3DO digital game console, that perform and enable ludomusical improvisation, and thereby to (re)discover the roles played by the digital differences made at the keyboard in its articulation and representation.

3-3 FROM BLACK BOX TO GLASSY SHELL

As form, process, and mode, the comic has repeatedly emerged from and entered into dialectical relations with its tragic counterpart. Tracing the genealogy of this relationship from Aristotle via Dante, Allanbrook noted that the reliance of comedy on vernacular modes of expression did not negate but rather inverted and ironized the elevated tragic register.¹⁴⁶ Equally importantly, the happiness of the *lieto fi e*—and, in instrumental terms, the forms and functions typified by the rondo—did not merely articulate a crude affective contrast to tragic doom and gloom. Since its reiterative performance of social harmony was both mandated and demanded by the playfully risky arbitrariness of the action staged theretofore, it hinged not only on the communal performance of memory, but also on remembering to forget (if not always to forgive).¹⁴⁷ In this sense, the ludocomedic restoration of the pieces on the board to their default configurations, ready to play once more, served both to conclude the onstage action and to anticipate the celebratory reunion of the cast at the curtain call that, according to the terms and conditions of the comic contract, was bound to follow. The *lieto fi e* and the curtain call blurred the boundary between theatrical play and the world beyond even as they drew it.¹⁴⁸

According to Aristotelian precepts, tragedy is caused by causality itself; conversely, the joyous contingency of comedy emerges from the inevitable deferral, elusion, or circumvention of the inevitable. Northrop Frye observed that these relations can be construed as reciprocal configurations of freedom and constraint, openness and closure: “Just as comedy often sets up an arbitrary law and then organizes the action to break or evade it, so tragedy presents the reverse theme of narrowing a comparatively free life into a process of causation.”¹⁴⁹ The inexorability of tragic plots is complemented by the Romantic search for hermeneutical meaning, a quest for reasons why things had to be *this* way rather than otherwise, predicated on singularity, autonomy, and necessity. It was in this spirit that Hegel solemnly disavowed the role played by caprice and whimsy in the creative process: “when a great artist finishes a work, we say ‘it must be so.’”¹⁵⁰ By contrast, the *ilinx* and *paidia* of comic imbroglione embrace the wild ramifications of unlikelihood in the knowledge that the eventual *dénouement* will restore order by undoing everyone’s undoing. In ludic terms, comedy relies on the *alea* of coincidence and accident, the arbitrary constraints of *ludus*, the *agōn* of behavior and events that stymie the stratagems of others, and Müller’s counter-Apollonian assurance that the consequences will be provisional, not fatal: even if one loses, one can always play again.¹⁵¹ Whereas tragedy fixes its gaze on the vanishing point that awaits us all, the contingency of comedy offers a vision of immortality, of possibilities that are both exhaustive and inexhaustible.

The very notion of a *Fassung letzter Hand* connotes a tragic inevitability that in Mozart’s case is amplified by his untimely death and the unfinished Requiem that has looped as a Romantic soundtrack through which philological, biographical, historical, and aesthetic signals are recursively processed.¹⁵² Yet the resonance of this narrative risks overpowering the virtuosic note- and wordplay of Mozart and his collaborators, which at once drew on and transformed the richly variegated comic mode they inherited. Mozart’s canonization militates against his (and Bassi’s) playfulness by sanctifying the master’s musical texts as authorized utterances rather than treating them as *canovacci* to be spontaneously elaborated in the course of performance.¹⁵³ In the Rondo of the Horn Concerto in D, K. (412+54)/386b, Mozart provided clues on how to perform such maneuvers by peppering the score intended for the soloist, Joseph Leutgeb, with the following commentary in Italian:

For you, Mr. Donkey—Come on—quick—get on with it—like a good fellow—be brave—Are you finished yet?—for you—beast—oh what a dissonance—Oh!—Woe is me!!—Well done, poor chap—oh, pain in the balls!—Oh God, how fast!—you make me laugh—help—take a breather—go on, go on—that’s a little better—still not finished?—you awful swine!—how charming you are!—dear one!—little donkey!—ha, ha, ha—take a breath!—But do play at least one note, you prick!—Aha! Bravo, bravo, hurrah!—You’re going to torture me for the fourth time, and thank God it’s the last—Oh finish now, I beg of you!—Confound it—also bravura?—Bravo!—oh, a sheep bleating—you’re finished?—Thank heavens!—Enough, enough!¹⁵⁴

Mozart's strategy illustrates the reversible reciprocity of ludomusical mimesis: a *canovaccio* can be derived from a piece of music just as easily as it can give rise to one.

As Domenico Pietropaolo observes, the *commedia dell'arte* emerged less from representations than from their (un)likely relations: its "comedy of opposites and the unexpected" was predicated on the predictability of ingenuity and the reiterability of novelty, enacting a critique of the hierarchical ordering of fixed identities that tacitly reinscribed it.¹⁵ This helps account for its particular affinity with the carnivalesque. If, according to Bakhtinian orthodoxy, carnival temporarily inverts binaristic distinctions based on class, gender, and behavioral codes, then the improvisatory formalism of the *commedia dell'arte* indicates that its play with boundaries served to underline the status quo: the subversion of social stratification relied on, and ultimately upheld, its clear articulation.¹⁶

As adumbrated above, the subversive potential of the comic style lay not in any particular social vision it advanced, but rather in its indiscriminate accommodation of every social register. Despite the ubiquity of the *lieto fine*, the emergence of comedy can thus be conceived as a stochastic rather than a teleological process, as Pietropaolo notes of the *commedia dell'arte*.¹⁷ Walking a fine line between surprise and redundancy, its subjunctive logic relied on the distinct yet connected functions of identification and differentiation, on operations that were performed and conveyed by way of mimetic strategies but that were formally independent of—and indifferent to—any specific connotations or values. Luhmann located the aesthetic origins of this mode in the flashes of improbable wit that characterized early modern *concetti*, which signified nothing on their own but rather "pointed to one another within a network of implicit and explicit references."¹⁸ From the delectable to the damnable, the sensible and moral impact of an action had to be derived as a consequence of the quicksilver play that simultaneously made it recognizable and distinguished it from its counterparts.

*Insofar as it made audible the purposively purposeless oscillations of the imagination, such play chimed with the Kantian aesthetics of instrumental music.*¹⁹ In light of Alexander Gottlieb Baumgarten's call for the poetic clarification of entangled sensual stimuli, the pointed contrasts on which the perception of topical variety depends meant that no musical elements could pass as unmarked: as Allanbrook put it, "when a musical gesture ceases to be A, it must be B, or C, or D."²⁰ Within the limits defined by the sublime and the ridiculous, Koch duly noted the arbitrary succession of "happy, charming, sad, or lofty emotions" that characterized music written in the *Kammerstyl* ("chamber style").²¹ But while the disinterested, promiscuous play of such music could please, many of Koch's contemporaries shared Kant's conviction that it was incapable of edification. William Jones simultaneously indulged and frowned upon the music of Haydn and Boccherini by comparing its wit and invention to "the Talk and Laughter of the Tea-table"; Christian Gottfried Krause went so far as to incorporate meaningless distinctions into his

own lexicon to condemn the empty *Mischmasch* and *Klingklang* of the Italianate comic style.¹⁶² From this perspective, Allanbrook's alphabetical logic recalls the propositions of Jevons's logical piano (Figure 19): once identity and difference have been established, discrete elements are made available for combinatorial processing, regardless of whether they denote *misch* or *masch*, *Kling* or *Klang*.

Such procedures readily lent themselves to performance at the keyboard of the clavichord or fortepiano, where digital maneuvers could produce dynamic contrast alongside clear distinctions between pitches, rhythms, and types of articulation. Ratter's observation that "the fortepiano was a quintessential locale for the play of topic" was elaborated by Allanbrook: "advertising its ability to project [contrast] . . . , the very name of [the fortepiano] . . . made clear how central that value was to late eighteenth-century taste."¹⁶³ Conceptually and audibly, the "near-cacophonous profusion of contrasts" thrown up by Mozart's welter of topical invention led Allanbrook to describe the first movement of Mozart's Keyboard Sonata in F, K. 332/300k, as nothing less than a "*commedia dell'arte* parade."¹⁶⁴ In line with Pietropaolo's formulations of the stochastic improvisatory processes of the *commedia dell'arte*, Allanbrook's algebraic representation of how musical gestures were identifiable, distinguishable, and combinable suggests how the ostensibly unruly systems of eighteenth-century comedy can nonetheless be conceived as operationally closed, in Luhmann's terminology.¹⁶⁵ As Mozart playfully put it in the motto that serves as the epigraph for Part II, *lusus enim suum habet ambitum*: every game has its own limits, which circumscribe and relativize its sphere of influence while rendering it functionally autonomous and internally consistent. Whether they denote pitches or gestures, identity and difference are both produced and articulated in terms of the relations between A, B, C, D, and so on.

The scores of Mozart's keyboard sonatas make this particularly clear insofar as they tend to eschew all forms of communication other than those that distinguish pitches, durations, articulations, tempi, affects, and formal functions from one another. The operational closure of such structures at once belies and depends upon the complexity with which they are coupled with their environments, which helps explain the seemingly inexhaustible fascination they continue to hold for performers and listeners.¹⁶⁶ As the paratextual annotations that constitute the *canovacci* of Mozart's pantomime and horn concerto suggest, moreover, the mimetic relations between the performance of musical configurations and the construal of their embodied implications as the staging of (a) play can feed back (and forward) into the system through which those configurations were generated.¹⁶⁷ Pietropaolo's codification of the stochastic dynamics of the *commedia dell'arte* thus enables us to conceive the realization of Mozart's *canovacci* not merely as sets of environmental stimuli and responses to his music, but as the operations of a theatrical system that was coupled to his scores and the musical performances that issued from them.

By way of such couplings, what Michael Spitzer describes as the “naturalization of the arbitrary sign” could take place.¹⁶⁸ In the course of mimetic play, certain identifications, distinctions, and clusters thereof became so stable that they assumed the status of conventions, at which point the recognizable fact of their identity and reiterability trumped—or became synonymous with—the referential qualities attributed to them. It is in this sense that masks, costumes, characters, and musical topics become and represent the very same things: at once medium and message, their communicative capacities are produced and delimited by their material forms. In this regard, the characters of the *commedia dell'arte* are akin to the classes that populate game-worlds from the chessboard to *World of Warcraft*.¹⁶⁹ August Wilhelm Schlegel made this ludic connection when addressing the paradoxically endless emergence of extemporized variety from a fixity that he understood to be both formal and representational:

The [standing masks] are in themselves not to be dismissed: so many central points of the national character are, as it were, captured in the comical representation, in externalities of dialect, costume, etc. Their repetition does not preclude the greatest diversity in the conception of the plays, just as in a game of chess a limitless number of complications becomes possible with a small number of pieces, precisely because each one has its particular move.¹⁷⁰

For Schlegel, as for Gottsched and Hegel, outward characteristics offered clues to fundamental questions of identity.¹⁷¹ Rather than seeking answers within the spirit of the individual, however, Schlegel found them ready-made in the notion of “national character,” itself an externalization that enabled different nations and states to be construed as actors on the geopolitical stage. Schlegel thus saw *mimicry* as integral to processes of recognition and distinction that constituted the ground rules for ludic interactions and their permutational concatenation.

Schlegel's brother Friedrich provided a complementary perspective on an aspect of the *commedia dell'arte* that yields further insight into the systematic implications of mimetic performance:

There are ancient and modern poems that are pervaded by the divine breath of irony throughout and informed by a truly transcendental buffoonery. Internally: the mood that surveys everything and rises infinitely above all limitations, even above its own art, virtue, or genius; externally, in its execution: the mimic style of an averagely gifted Italian *buff*.¹⁷²

More a paradigmatic instance than a definition of Romantic irony, this gnomic pronouncement draws a distinction between the internal and the external to transform mere contrast into the ground from which transcendental meaning can emerge.

Tellingly, the role assigned to the Italian *buff* is performative rather than (self-)authorial, indicating how the “mimic style” complicates the constative function of utterance. The ludic aspect of *mimicry* reveals how the performance of mimesis

can unsettle the very distinctions between identity and difference, truth and deception: as Caillois pointed out, a child pretending to be a train both *is* a train and *is not* a train, just as Schlegel's *buff*—like Rameau's pantomimetic nephew—reveals himself through the imitation of others.¹⁷³ Elsewhere, Diderot wrote of the paradoxical logic by which comedians could not but disrupt the very illusions they performed.¹⁷⁴ Analogous logic underpins Danuta Mirka's definition of musical topics as "styles and genres taken out of their proper context and used in another one": a topical "march" both is and is not a march insofar as it stages its own appearance.¹⁷⁵ The topical frame simultaneously presents the illusion and constitutes the means of identifying it as such.

For Friedrich Schlegel, the transcendental necessity of poetic form was at self-consciously Romantic odds with the earthy pragmatism of the *commedia dell'arte* tradition he invoked to mediate it. Even the most historically grounded commentators have shared the conviction that the temporal and spatial juxtaposition of topics and styles in comic music of the later eighteenth century admits, invites, or even impels a playfully ironic approach based on the identification of discrepancies between statement and implication, expectation and delivery.¹⁷⁶ In Mozart's world, the archetypal Italian *buff* was Francesco Benucci, who played Figaro and Leporello with a degree of wit and bravura that far exceeded the norm.¹⁷⁷ The latter role abounds with musical and dramatic opportunities to pry open the ironic gap between the politesse of social mores and the agonistic mechanisms of greed and violence that they conceal: Leporello critically observes this system even as he acts—and suffers—within it.

Taking this one stage further, the comedic performances of Bassi were renowned for their metacommentary on the tics and flaws he observed in his fellow performers.¹⁷⁸ For the Prague premiere of *Don Giovanni*, Mozart himself colluded in such metaplay not merely by his virtuosic feat of staging the "multitracked" performance of three different genres of dance music, but by diegetically alluding to a trio of operas including his own *Figaro*, in which Bassi had played Count Almaviva the previous year.¹⁷⁹ Alongside Mozart's *Glockenspieler* with Schikaneder, these phenomena display a degree of reflexivity that Romantic poets and playwrights such as Tieck would exponentialize, adopting recursive strategies of doubling that could spiral into infinite regress.¹⁸⁰

As well as serving rhetorical, literary, and dramatic ends, these strategies could be applied to the mechanical assembly of eighteenth-century musical devices from a common repository of note heads, numerals, beams, and flags. To the extent that the system of *galant* instrumental music as a whole was composed of compressible patterns (whether construed as schemata, *Satzmodelle*, *Gänge*, *suites*, *movimenti*, or *clausulae*) that were encodable by ellipses, lines, numerals, and other symbolic means, this system too meets Luhmann's criteria for operational closure. Both despite and owing to its communicative coupling

with the cognitive systems of composers and the broader social environment, its multidimensional complexity was ultimately derivable from and expressible via a common lexicon of pitches, durations, figures, topical gestures, and metrical patterns that were combinable in a vast—but, crucially, finite—number of ways. Tellingly, however, Gjerdingen claims that the operations of “nesting, blending, reference, and allusion” performed in the course of planning and realizing the most intricate instrumental music separate these activities from the schematic concatenation of simple elements performed by players of *Würfelspiele* and users of pedagogical manuals.¹⁸¹ He locates the source of these complex organizational processes in cognitive and digital praxis, the “nonverbal traditions of *partimenti*, *solfeggi*, and actual composition.”¹⁸² How much further might we go in attempting to account for the extraordinary flowering of such processes without simply attributing it to the genius exhibited by a select handful of individuals?

One answer can be extrapolated from observing the observations made above. Although Mozart might have scripted Benucci’s staging of Leporello’s ironic commentary on the systems that afforded and constrained the actions of all three, the very musical articulation of this convoluted state of affairs appears to comment on itself. From this perspective, the dialogical qualities of such music have less to do with questions of persona and character and more to do with “the ‘structural’ fact of riposte,” as W. Dean Sutcliffe puts it: a response not only communicates but also acknowledges the conditions under which communication has occurred.¹⁸³ While one can identify or invent avatars to lend such agency a human face, its differential dynamic might also be apprehended in terms of a feedback loop that flows between the distinct positions occupied by actor and observer, performer and listener, topic and “topic”—in other words, from music’s nonidentity with itself.¹⁸⁴ These properties imply that the play of instrumental music—particularly, as Diderot’s fantasy of the self-conscious, -playing, and -reproducing harpsichord suggests, music that is brought forth and rendered at the keyboard—could recursively emerge from a system capable of improvisation, of generating unforeseeable outcomes from its internal resources alone.¹⁸⁵ In the terminology that Luhmann adapted from the Chilean biologists Humberto R. Maturana and Francisco J. Varela, such a system is autopoietic.¹⁸⁶

Luhmann’s redeployment of autopoiesis from its native biological habitats to inorganic systems of communication and mediation has engendered much debate.¹⁸⁷ As Landgraf demonstrates, however, the abstract principles of emergence and self-organization assume particular historical and cultural cogency when brought to bear on the increasing autonomy of art in conceptual, discursive, and material forms around the turn of the nineteenth century.¹⁸⁸ According to ideas promulgated by Goethe as well as the Jena Romantics, the production of art from algorithmic blueprints such as Niedt’s and Geminiani’s was no longer sufficiently innovative, no matter how endlessly varied the results might be: on

the contrary, each viable artwork had to create “a small world unto itself, where everything happens according to certain laws, and needs to be judged according to its own laws.”¹⁸⁹ Translated into Luhmannian terminology, an artwork could no longer simply adhere to preexistent codes that determined aesthetic value, but had to become a self-programming system whose operations at once defined the criteria by which they were evaluated.¹⁹⁰ As Landgraf points out, this mirrors the changing function of media: both despite and owing to the efforts of Niedt and Geminiani, the diffusion of print culture reduced the need for improvisation as a “mnemonic aid,” a form of cultural memory based on the reiteration and variation typical of oral and manual tradition, and instead promoted “originality and innovation.”¹⁹¹

The perception of art in these shifting terms helps clarify the paradoxical appearance of Mozart’s keyboard music as simultaneously “open” and “closed.” In keeping with its liminal historical status, the accidental and fungible qualities that Ludwig Holtmeier ascribes to its themes and forms are nonetheless sealed inside a “seamless, glassy shell which denies entry to their interior.”¹⁹² While this might be read as a wistful acknowledgment of historical and cultural distance, it also reflects a conception of Mozart’s sonatas as the output not of an impenetrable cognitive “black box,” but of mechanisms that are visible—or at least inferable—even as they remain tantalizingly inaccessible to the observer. This transparency contrasts with the opacity of C.P.E. Bach’s *Einfall*, which relies on the active participation of observers while concealing the mechanisms by which aleatoric input is converted into orderly output. The ludomusicality of the *Einfall* ultimately resided in the pleasure of staging improvisation as a collaborative and arbitrarily purposive sequence of events. Conversely, Mozart’s sonatas seem to have departed from extemporization as a means of kick-starting a playful process that proceeded to unfold according to its own laws, however much they might be retrospectively drafted in conventional terms.¹⁹³ Such a model of poiesis chimes with Koch’s definition of improvisation and its functional relation to the art of composition.¹⁹⁴

By the turn of the nineteenth century, the ludic mechanisms of *Würfelspiele* seemed to have played themselves out. Yet Goethe’s invocation of a “small world unto itself, where everything happens according to certain laws” neatly encapsulates Huizinga’s notion of the magic circle.¹⁹⁵ One need not accept Luhmann’s grandiose claims concerning the autopoietic ontology of social and communicative systems to recognize that, as snow globes attest, both randomness and operational closure can be expressly contrived under the rubric of play. As formal systems, games avoid predictability by constantly absorbing and generating new information within a relatively rigid and consistent framework. Conway’s *Game of Life* stands as a paradigmatic example of an operationally closed computational simulation that directly engages with the evolutionary and emergent properties of autopoiesis as conceived by Maturana and Varela. From models of DNA evolution

to dating simulations, these recursive principles have reconfigured the topology of digital societies. Furthermore, their genealogy incorporates a particular strain of ludomusical technology that, despite its marginal historical significance, materialized and united concepts associated with both aesthetic autonomy and mechanical automation by way of aleatoric contingency.

3-4 THE CASE OF WINKEL'S COMPONIUM

While music emerged from *Würfelspiele* and pedagogical compositional methods such as Niedt's and Geminiani's via the same combinatorial mechanisms, creative responsibility was assigned in varying proportions and to different quarters, as noted in Key 3-1. Whereas *Würfelspiele* scattered it among players and the dice they threw, Niedt sought to concentrate it in the mind and body of the aspiring *Kapellmeister*: "The eager learner will achieve facility ... through diligent application and through this introduction, after he has practised it a hundred times."¹⁹⁶ Niedt's readers must work their way toward competence by way of painstaking repetition: only with the benefit of hard-won experience will they be ready to share the fruits of their labors with others. Conversely, the pleasure of dice games and other ludic mechanisms such as C.P.E. Bach's *Einfall* lay in the seemingly effortless production of novelty that left players free to consume, observe, and share it. Although such pleasure still relied on compositional labor, the source of that labor was hidden from view. To detractors of musical play, Bach's diversionary tactic of disguising the operation of his mechanism betrayed the emptiness lurking behind its cheerful façade. As we have seen, however, the very qualities that rendered play morally suspect enabled it to serve as a touchstone for the aesthetic qualities of autonomy, disinterest, symmetry, and beauty as adumbrated by Kant and articulated by Schiller. *The point of play lay in its very pointlessness, the inevitability of its undecidability, the constancy of its capriciousness, and its time-honored novelty.*¹⁹⁷

In a literal sense, the black—or, more commonly, brown—boxes that encased automated mechanisms of all kinds in the eighteenth and early nineteenth centuries performed a similar function. By concealing their inner workings, the cabinets of mechanical devices both invited and foreclosed speculation into the inventor's methods—and on occasion, as was notoriously the case with Kempelen's chess-playing "Turk," his legitimacy.¹⁹⁸ As Schott pointed out in his *Magia universalis*, the question of whether a particular phenomenon was a wondrous illusion or a deceitful delusion depended on the astute judgment of the observer as much as on the techniques of the designer.¹⁹⁹ As recently as 1978, Arthur W.J.G. Ord-Hume alluded to Winkel's "componium" (Figure 45), an elaborate double-barreled automatic organ, as either "the most remarkable mechanical musical instrument in the world" or "the biggest 'con' of all time," registering the peculiar oscillation between awe and skepticism that attends encounters with technological marvels.²⁰⁰



Figure 45. Diederich Nicolaus Winkel's "componium" (1821). Photograph © Museum of Musical Instruments, Brussels. Reproduced by permission.

Ord-Hume's uncertainty stemmed from the terms in which the componium was billed at its Parisian debut in 1823: how could a mechanical organ be personified as "l'improvisateur musical"?²⁰¹ At this initial exhibition, the playerless play of the componium elicited astonishment from musicians, mechanics, and amateurs alike. While mechanical organs capable of producing and coordinating diverse sounds in the manner of an orchestra were familiar enough, Winkel's instrument was singular in that, in Fétis's words, it was "endowed with the capacity to improvise" a seemingly endless sequence of variations on a prescribed theme.²⁰² As Fétis observed, the componium could be placed directly in the lineage of the ludic combinatorial techniques deployed by Kirnberger *e tutti quanti*.²⁰³ In this regard, the properties of the componium's dual pinned barrels, each of which produced two bars of music in alternation with its counterpart, are clear enough: each two-bar excerpt is pinned alongside seven harmonically congruent variants, from which serial selections fabricated the predictably unpredictable results of a dice game.

But the componium seemed to follow no preset path in choosing among its eight modular options at each two-bar interval: in other words, it seemed both to throw and to read its own invisible dice.

Since Fétis and other witnesses could not adequately account for the componium's quasi-miraculous powers of invention, the mathematician Jean-Baptiste Biot and the music theorist Charles Simon Catel were commissioned to report on its workings. Their findings were strikingly vague, addressing effect rather than cause:

When this instrument has received a varied theme, which the inventor has had time to fix by a process of his own devising, it “decomposes” the variations itself. Reproducing their different parts in all orders of possible permutations, just as the most capricious imagination might do, it forms successions of sound so diversified, and guided by a principle so arbitrary, that even the person best acquainted with its mechanical construction is unable to foresee at any given moment the sounds its fantasy is about to produce.²⁰⁴

This verdict confirmed that the componium could indeed improvise insofar as it could produce unforeseeable musical phenomena. Whereas paper machines such as *Würfelspiele* could perform similar tasks, the manner of their operation was at least theoretically discernible by those who rolled the dice: the artificial intelligence of the componium, conversely, was apparently opaque to all but the laconic Winkel himself, even when denuded of its impressive cabinet (in which undignified state it languishes today). The very attempt to convey the scope of its improvisatory abilities left Biot and Catel grasping for words and resorting to raw numbers to convey the scale of its technological sublimity.²⁰⁵

If one were to suppose that [the componium] play one single air continuously, without interruption, modifying it by its single principle of variability, it could, without reprising exactly the same combination, continue to play not merely for years and centuries, but for a number of centuries so immense that, though written numerals can express it, common language can not.²⁰⁶

The componium occasioned the failure not only of witnesses to give a satisfactory description of its operation, but also of language itself to provide the requisite means of doing so. In this regard, it recursively (re)presented a problem central to the epistemology of nineteenth-century improvisation: How were observers to know whether the performance unfolding before them was “genuinely” extemporized or not? Although Landgraf deftly exposes the contingency of the premises and distinctions on which this dilemma was founded, Ord-Hume's twentieth-century framing of the componium as either an unparalleled marvel or an unspeakable hoax reveals the strength and longevity of its binaristic logic.²⁰⁷

The bewilderment that greeted the componium's mysterious mechanisms can be considered in light of Czerny's puzzlement at how the quintessentially human attributes of “reflection and attention” failed to account for improvisation

at the keyboard: instead, as we saw above, “we must leave nearly everything to the fingers and to chance.”²⁰⁸ On the one hand, Czerny’s reference to the fingers acknowledges the mechanistic digital principles that underpinned eighteenth-century improvisatory techniques, driven into the subconscious by the type of repetitive practice recommended by Niedt and demanded by his own works. On the other, his invocation of chance gestures toward the workings of the mind that defy rational explanation.

In(side) the case of the comptonium, these two aspects were materialized by its dual barrels and the combined operations of its gears and disks respectively. The evocative terms of “improvisation” and “fantaisie” invoked by Fétis, Biot, and Catel are borne by each pair of the comptonium’s surviving cylinders.²⁰⁹ That notwithstanding, they are in themselves unremarkable examples of the time-tested digital techniques of storing and programming musical information that can be traced back to the pegged barrels of organs such as Caus’s (Figure 3). In his description of the comptonium for the catalog of the hardware housed at the Musée Instrumental in Brussels (1880), Victor-Charles Mahillon was the first to reveal in detail the secret of how its improvisatory capacities lay in the technical means by which its barrels were rotated.²¹⁰ The instrument’s complex array of coiled gears and elliptical disks relied on traction, gravity, and inertia to generate rotations of variable and unpredictable amplitude, thereby transforming it from a trivial into a nontrivial machine (to adopt the terminology of Heinz von Foerster).²¹¹ According to Philippe John Van Tiggelen’s ludic analogy, the mechanism combined aspects of the yo-yo and the roulette wheel in order to inject elements of *alea* into its own concatenation of modular musical components.²¹² Czerny’s improvisatory prerequisites of “the fingers” and “chance” were thus manifested within the “lightless, claustrophobic space” of the comptonium by its digital means of encoding, permuting, and performing notes and its analog mechanisms of *alea*, based on geometrical as well as arithmetical principles.²¹³ The comptonium played a ludomusical game of double-barreled roulette by way of a digital-analogical calculus that distinguished it from its mechanical stablemates and allied it with the embodied, cognitive, psychic, social, and technological epistemologies of improvisation.

In the Parisian press, the comptonium was discursively situated as the latest exhibit in the long-running debate concerning the impact of automation on the shifting boundary distinguishing the human from the mechanical.²¹⁴ *La Pandore* placed the name of Winkel alongside Vaucanson and Jaquet-Droz as exemplars of human genius at whose hands machines had been “given the sentiment that man received from the hand of God.”²¹⁵ Others were skeptical of such hyperbolic claims: the acerbic Castil-Blaze dismissed the monotonous variety of the comptonium’s “improvisations” as the “artifice of a charlatan.”²¹⁶ The anonymous writer of a letter published in the *Moniteur universel* took a more nuanced approach. While adamant that the instrument’s “improvisations” did not qualify as such, (s)he nonetheless praised Winkel’s mechanical ingenu-

ity: if the componium could not extemporize with the imaginative flexibility of a human, then neither could a human match the relentless novelty and tireless consistency of the componium's four-square forms of spontaneous invention.²¹⁷

Beyond the polemics of vitalists and mechanists, these observations suggest that the chief interest of the componium lay in its mediation *between* human and machine. Initially, it raised the question of whether the realm of improvisation was exclusively human or whether it could be artificially simulated; beyond that, it prompted an interrogation of the extent to which the aesthetic conditions under which improvisation could emerge were synonymous with a particular set of technical resources. These relations come to the fore in the double entry for "melograph" in Gustav Schilling's *Encyclopädie der gesammten musikalischen Wissenschaften* (1840).²¹⁸ On the one hand, "melograph" is defined in the sense of Euler's coinage, as a keyboard-based device for capturing human extemporization; on the other, as Trippett points out, it describes spontaneous mechanisms such as the componium's that are capable of generating music autonomously and automatically.²¹⁹ The same term thus refers to different stages of the technical processes by which emergent music was produced and stored in the forms of digital code and memory.

In an attempt to defuse Julien Offray de La Mettrie's incendiary *L'homme machine* (1748), Balthasar Ludwig Tralles had numbered mathematical calculation and music among the human talents that testified to the existence of the soul.²²⁰ A century and a half later, in the wake of countless counting machines as well as Winkel's componium and Debain's antiphonel, the issue of how and where to locate the soul was no longer merely theological and philosophical: it had become a legal and technical matter.²²¹ In a ruling beyond the satirical reach of Swift or Hayes, the Court of Paris determined in 1895 that the "soul" of any given automatic musical instrument resided in the perforated cards that programmed it.²²² From a legal standpoint, the question hinged on ownership rather than on authorship, on music's communicable existence in a particular material form rather than on the more or less mysterious means by which it had come into being.

Aesthetically, too, the brute fact of inscription trumped the ephemeral experience of improvisation. Gooley presents a compelling account of the factors that led to the decline of extemporization as artisanal practice, which were concomitant with its elevation as artistic ideal.²²³ Coeval with the twilight of the *Kapellmeister* culture represented by Niedt, Mattheson, and Riepel was the rise of cosmopolitan keyboard virtuosi such as Liszt and Sigismund Thalberg. In line with Landgraf's observations on the effect of print culture on theatrical improvisation, Gooley and Gjerdingen have noted that the contingency of musical extemporization was stylized, ossified, or erased by the regulative technology of the (published) work, the mass (re)production of which belied the putative singularity of its conception even as it testified to it.²²⁴ These effects can be registered by keeping score of the agonistic back-and-forth between Liszt and Thalberg, in the course of which Liszt cast aspersions on his rival's powers of invention by comparing the vapidness of Thalberg's interminable

arpeggiation to the extemporized effusions of Winkel's *componium*.²²⁵ Divorced from its pragmatic functions and pedagogical basis, the process of improvisation was reframed as a Romantic act of divination, the invention of an imagined past that, in Luhmann's terms, represented a "more archaic authenticity" that could no longer be performed, observed, or even remembered.²²⁶ In this regard, improvisation assumed a similar function to that which Schiller accorded play: while ostensibly opening up the future to the radical contingency of action in the here and now, it served to conjure a paradisaical image of how things might have otherwise been.²²⁷

Th s connection between spontaneity and play hinges on the paradoxical sense in which the unforeseeability of both turns out, in retrospect, to have been overdetermined. As Justin E.H. Smith points out, it can be traced back to the early modern notion of *lusus naturae*.²²⁸ Such post-Plinian "games of nature" were held to produce phenomena from the wondrous to the aberrant in ways that defied all prediction and yet were autonomous in that they were "determined only by . . . intrinsic properties."²²⁹ In this Leibnizian sense, spontaneity broadly accords with Luhmann's autopoietic account of how new information can emerge from within an operationally closed system. Yet, as Smith notes, spontaneity could also denote the opposite state of "being entirely undetermined by prior conditions . . . and of arising from the free activity of some mind or mindlike power."²³⁰ It is this notion of freedom on which Schiller's *Spieltrieb* depends: the exercising of reason can release humankind from the oppression of material laws by recursively processing the logic behind their compulsion, thereby transforming them into courses to be freely followed.²³¹ With the *componium* in mind, it is telling that these seemingly contradictory implications of "spontaneity" are both etymologically rooted in the ancient Greek αὐτόματος (*automatos*).²³² In aesthetic terms, the codependence of automatism and autonomy gave rise to Romantic anxiety and wishful thinking that sought to distinguish one from the other. Th *componium* not only provided material evidence of this codependence, but demonstrated that the very desire for self-willed autonomy was a response to—even a function of—thoughtless automatism.

Derrida's summary of the Romantic reinvention of invention as the production of a "technoscientific or technopoetic apparatus . . . capable of a certain self-reproductive recurrence and even of a certain reiterative simulation" resonates with the *componium's* playing out of principles that he, like Smith, traced back to Descartes and Leibniz.²³³ For Derrida, the aesthetic and material limits of the *componium*—its autonomy as much as its automatism—would have stood as evidence for his fundamental belief that since "the other is . . . not inventible," improvisation is ultimately impossible.²³⁴ As Landgraf and Michael Gallope point out, however, Derrida's recalcitrant pessimism regarding improvisation is itself symptomatic of the very Romantic patterns of thought—the binarization of self and other, the calculable and the incalculable, the necessary and the impossible—that it diagnoses.²³⁵ Once set in motion, improvisatory play shuttles between and bounces off these limits: as Luhmann wrote of art in general, its rules regulate its

operation “without prohibiting the opposite. . . . The only requirement is to stay clear of two limits: the necessary and the impossible.”²³⁶

The laissez-faire plurality of such play came into conflict with the requirement that a work of art be singular: while it must “remain within the modality of contingency,” Luhmann argued, it must “draw its power to convince from its ability to prevail in the face of other self-generated possibilities.”²³⁷ For Goethe, as we have seen, this power was derived from the Kantian sense of lawfulness according to which an artwork created, monitored, and explored its own “small world.”²³⁸ From this perspective, the problem with play—and, specifically, with *alea*—was not its scrupulous lawfulness, but the sheer arbitrariness of its judgments. The particular sequence of notes that emerged from the comptonium’s aleatoric play was exceedingly improbable—but, within the affordances and constraints of its brown box, it was more or less as likely as any other.²³⁹ Detached from the social world of *Würfelspiele*, the autonomy of the comptonium offered no rationale for coming to terms with contingency, no scope for a hermeneutical observer to explain why *this* might happen rather than *that*.²⁴⁰ Despite Winkel’s genuine ingenuity, Castil-Blaze’s suspicions were well founded: as the comptonium’s endless variations became monotonously normative, the sublimity of its combinatorial possibilities shaded into banality.²⁴¹

As a result, the public’s attention quickly shifted elsewhere. Subjected to neglect and abuse, the comptonium deteriorated over the course of the nineteenth century, rendering the prospect of restoration to its original condition unlikely.²⁴² Rather than representing the boundless possibilities of an immortal musical future, the comptonium stands today as a monument to evanescence, obsolescence, and entropy. Its perpetual generation of musical novelty having proved all too temporary, it remains marooned in the past as little more than a media-archaeological oddity. As a form of automated ludomusical amusement on display in commercial spaces of dubious repute, however, it spawned innumerable successors in the form of slot and arcade machines such as those manufactured by the Caille Company in Detroit.²⁴³ Several models, including one designed for the Parisian market and given the unglamorous name of *la reliable* (ca. 1895–1902, Figure 46), combine the (more or less) aleatoric mechanism of a roulette wheel with the melographic code of a pinned music-box cylinder. Unlike in the comptonium, and for legal as well as aesthetic reasons, the audibly reliable rotation of the latter accompanies rather than constitutes an unforeseen stroke of fortune.²⁴⁴ In the case of *la reliable*, the playing of music by J.S. Bach or Handel is predicated not on the unpredictable outcome of the player’s trivial actions (which here involve inserting a coin, winding the music box, and pulling a lever to set the game in motion), but on the certitude of its own observability, and thus the social capital—not to mention the pleasure—that can accrue from the punctilious recreation of works that continue to stand the test of time.

From this perspective, the paradoxical unpredictability of *la reliable* comes closer to the gregarious communicativity of C.P.E. Bach’s *Einfall* than to the routes blindly charted by the comptonium’s binary trees. In line with Shannon’s



Figure 46. *La reliable*, manufactured by the Caille Company (ca. 1895–1902). Photograph reproduced courtesy of the Collection Jean-Claude Baudot and the Gauselmann Collection at the Deutsches Automatenmuseum, Espelkamp.

codification of information theory, the componium had no regard for semantic or mimetic meaning of any kind: its complex programming simply served to relay Winkel's varied musical utterances by maximizing their informational content (measured in terms of their moment-to-moment unpredictability) and thereby minimizing their redundancy (despite their structural uniformity).²⁴⁵ Eventually, however, its technology would be redomesticated and turned to social ends, just as the syntactical principles of Bach's *Einfall* would be technologically



Figure 47. Cover of instruction manual for *Sid Meier's C.P.U. Bach* (MicroProse Software, 1994).

Video 5. Introductory cinematic sequence and “gameplay” from *C.P.U. Bach*.

To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.10>



refitted and applied to the musical idiolect of his father. Unlikely though it might have seemed to either man, Bach’s eighteenth-century paper machinery and Winkel’s nineteenth-century mechanisms of spontaneity were destined to be brought together within the twentieth-century black box of a digital game console and represented onscreen by the brown box of a digitized harpsichord.

3-5 THE INVISIBLE THUMB ON THE SCALE

In 1994, MicroProse Software published *Sid Meier's C.P.U. Bach* (Figure 47), a “game” designed by Meier and the composer Jeffery L. Briggs for the Panasonic 3DO Interactive Multiplayer digital game console that had been launched in

North America the previous year. Like its near-namesake's *Einfall*, *C.P.U. Bach* algorithmically generates "new" music loosely cast in a baroque idiom. As with the componium, moreover, the creative powers of *C.P.U. Bach* were said to verge on the immortal: "with *C.P.U. Bach*," the box confidently asserts, "great composers no longer have to stop composing." While Meier and Briggs elsewhere distanced themselves from such rhetoric by claiming that *C.P.U. Bach* aims for interest, variety, and stylistic congruity rather than the production of masterpieces, the musical forms within which it "improvises" are explicitly modeled on the output of J.S. Bach.²⁴⁶

C.P.U. Bach's punning title and pixelated portrait of Bach point up the problem of personification that has attended mechanized and automated technologies of performance from the componium to Ableton *Live*. The software's introductory cinematic sequence (Video 5) pursues the Diderotian conceit that a harpsichord can produce its own music.²⁴⁷ Instead of strings that resonate in mutual sympathy, however, its case houses a printed circuit board on which memory is stored in RAM modules and sensation routed through the eponymous central processing unit, inhabited by a Bachian homunculus seated at the organ. To human observers, *C.P.U. Bach* is no less of an inscrutable black box than the 3DO console itself. As with the componium, its inner workings remain concealed from view: the only index of the arduous creative processes that distilled drops of effervescence from C.P.E. Bach's countenance is the lengthy loading screen that heralds each performance. Players interact with the software's front end via a set of menus and sliders that enable them to specify the relative probability that the next piece will feature a particular genre or instrumental combination. Beyond that, the software effectively plays (with) itself. Human input is limited to the selection of the visual style in which the music is represented: modes include "Bach" at the harpsichord, a kaleidoscope, a picture gallery, and a didactic "analytical" mode that features a piano-roll visualization of the music as it unfolds alongside textbook descriptions of its formal processes and functions.

As with musical dice games, however, players' limited hands-on involvement with the operational logic of *C.P.U. Bach* tells only part of the story: the rest is provided by the aesthetic and social ends to which the software is put. Anticipating such needs, the developers thoughtfully mapped the parameters of its musical styles onto "party," "soirée," "literary," and "reverie" concert modes, indicating the affluent, aspirational, and leisured social stratum at which *C.P.U. Bach* was primarily aimed—not so far removed, *mutatis mutandis*, from the *bürgerlich* households targeted by *Würfelspiele*. Addressing the purchaser as both player and patron, Meier and Briggs were pleased to confirm that "you now have your own composer on your domestic staff"²⁴⁸ Insofar as it ranges in quality from the uncannily plausible to the dutifully absurd, the music produced by *C.P.U. Bach* is indeed on a par with the output of a *Kapellmeister*-in-training diligently practicing Niedtian algorithms for the delectation of his patron.

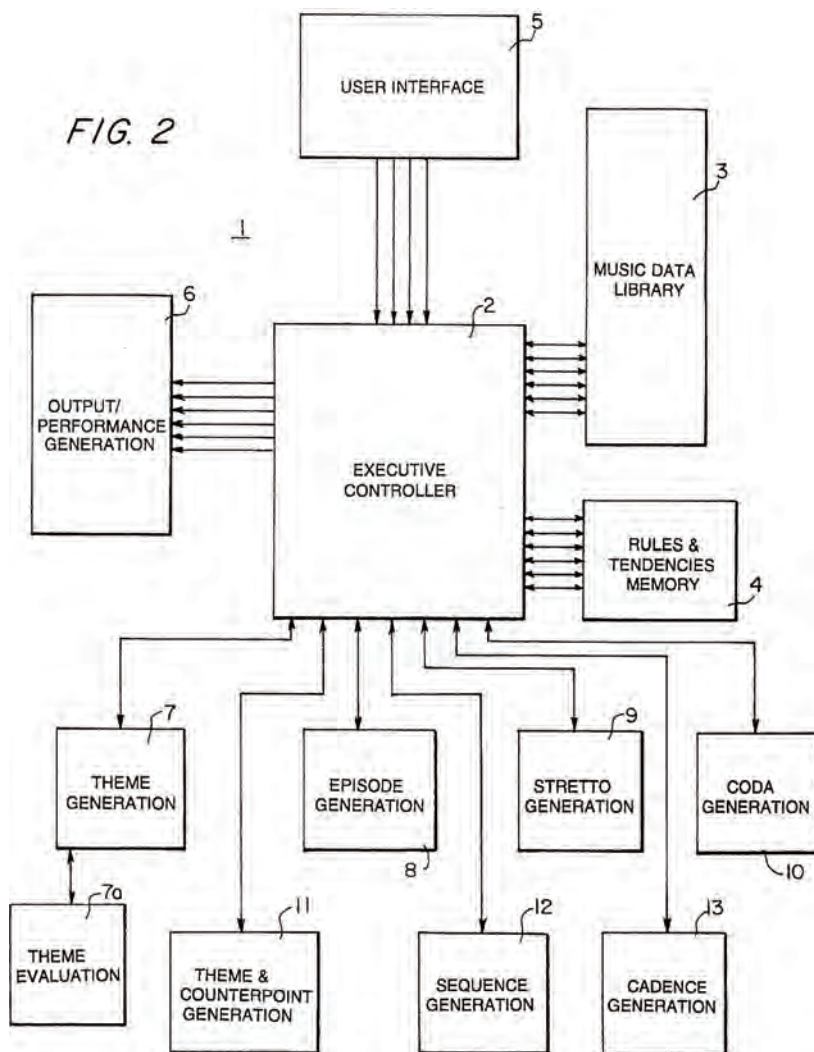


Figure 48. System block diagram of *C.P.U. Bach's* structure and operational principles, reproduced from Sidney K. Meier et al., "System for Real-Time Music Composition and Synthesis," US Patent 5,496,962 (filed 1994).

In this light, it is perhaps unsurprising that the patents written to protect *C.P.U. Bach* (Figures 48 and 49) simultaneously reveal that it "improvises" music via the generation of quasi-random numbers, the application of rules, tendencies, and patterns, and the concatenation of Markov chains.²⁴⁹ Distributed between Winkel and his machine, these elements were independently present in the design and operation of the componium, but their coordination in *C.P.U. Bach* attains a different degree—if not order—of self-organization. The schematic overview

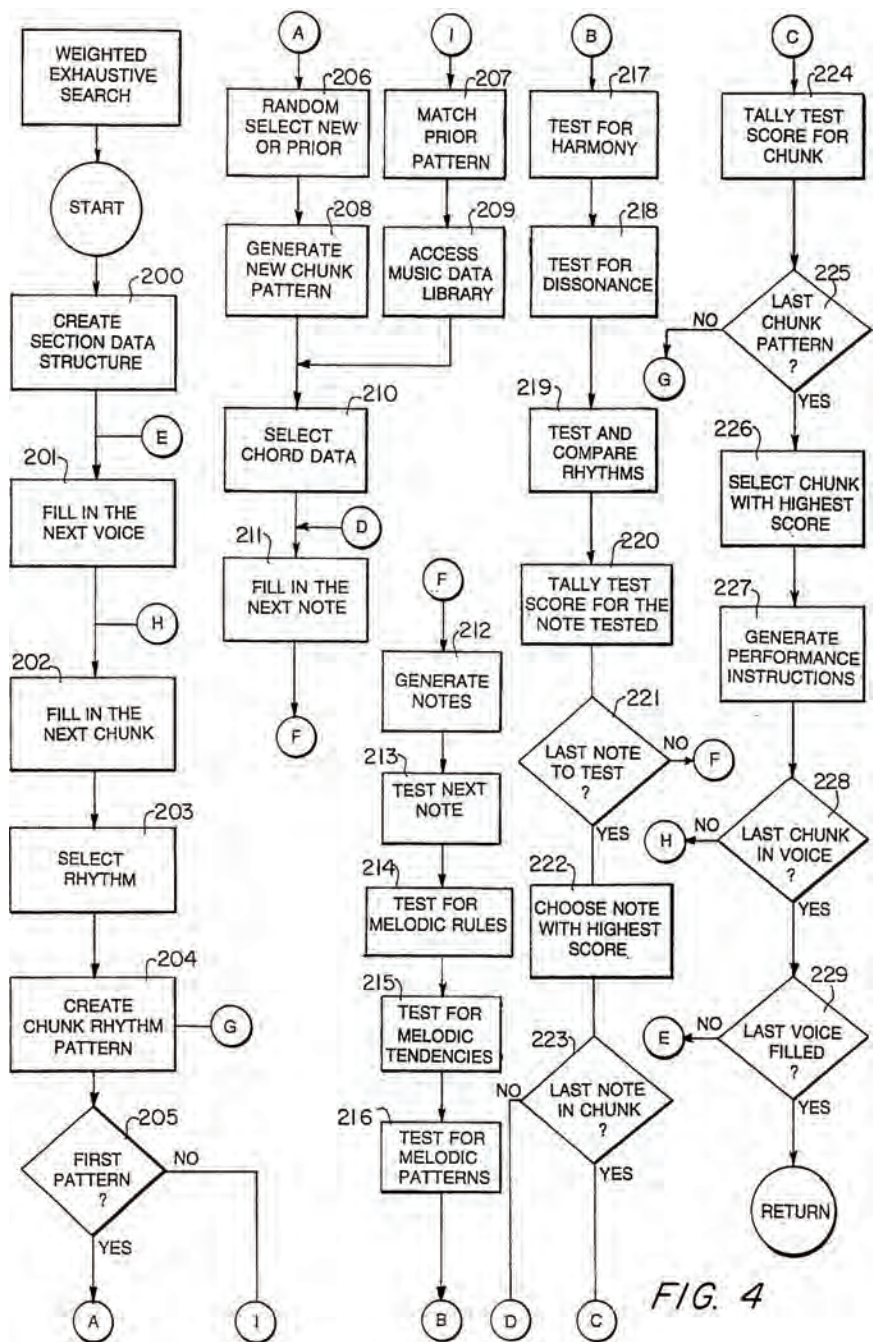


FIG. 4

Figure 49. Flowchart of C.P.U. Bach's weighted exhaustive search process, reproduced from Meier et al., "System for Real-Time Music Composition and Synthesis."

of *C.P.U. Bach*'s systemic structure (Figure 48) illustrates how it is centered on an "executive controller" that stands in for the composer's authority: after generating a random starting point, it draws on structural information stored in a "music data library," applies rules and tendencies derived from textbooks (including Rameau's *Traité de l'harmonie*) via conditional logic routines, and takes into account the player's input via the user interface in order to generate and organize sequences of musical events that conform to its self-defined generic norms.²⁵⁰

Unlike the componium's cylinders, gears, and disks, the programming mechanisms of the 3DO are Turing-complete, which means that *C.P.U. Bach* is capable of inspecting its own state and using that data to inform the programming of its operations.²⁵¹ The capacity of recursive processing enables it not merely to observe the consequences of its musical propositions, but to evaluate them quantitatively, compare them to alternatives, and select the best available option, as illustrated in Figure 49.²⁵² As a result, *C.P.U. Bach* does not merely "improvise," but critiques and revises what emerges prior to sending the resultant data to its performance generation module, where analogous decisions are made concerning articulation, tempo, dynamics, and phrasing before the stream of MIDI data is rendered audible. In this sense, it mimics players of a *Würfelspiel* who judge the modules indicated by their dice rolls on aesthetic grounds and can choose to roll again until the results are deemed worthy of performance.

C.P.U. Bach's accommodation of tendencies alongside rules indicates that it operates using multivalued "fuzzy" logic as well as its binary Boolean counterpart. Accordingly, its weighting of certain possibilities over others is drawn from its library of data as well as its own "experience": second-order observation allows the blind randomness of aleatoric permutations to be framed from the eighteenth-century perspective of Bayesian probability.²⁵³ While *C.P.U. Bach* evinces limitless generative potential, its capacity to improvise is based on a particular set of assumptions, accumulations, and value judgments concerning (un)acceptable and (un)desirable sequences of events: the software's tendency to "favor continuing a scale passage" puts an invisible thumb on the scales that hold future musical possibilities in the balance.²⁵⁴ Although individual aberrations are permitted, the unforeseeable succession of notes on a moment-to-moment basis conforms to the same large-scale patterns of statistical regularity that ensure the long-term profitability of machines such as *la reliable*, lotteries, insurance companies, and even "the stability and happiness of empires," according to the astronomer and mathematician Pierre-Simon Laplace.²⁵⁵

For Meier, the high cultural value of J.S. Bach's music is associated with its "universality," which indicates his appreciation not only for the beauty of its rational order, but also for its attributes as a musical data set that can be subjected to replication, transcription, transcoding, and algorithmic processing.²⁵⁶ Bach serves as a synecdoche for Western art music and the meteoric rise of its social and cultural capital, which was coeval with European colonial expansion, a period that Meier and Briggs—like so many others—seem to view as a golden age. In this regard,



Figure 50. Detail from Adolph Menzel, *Flötenkonzert Friedrichs des Großen in Sanssouci* (1788–89), featuring C.P.E. Bach at the keyboard (Alte Nationalgalerie, Berlin). Photograph by Jörg P. Anders.

Figure 51. Screenshot from *C.P.U. Bach*.

C.P.U. Bach's simulacrum of an autonomous flautist, accompanied by an obedient harpsichordist who possesses such discretion as to disappear, cannot help but evoke C.P.E. Bach's close relationship with Frederick the Great, particularly as portrayed by Adolph Menzel (Figures 50 and 51).

The mechanical play of *C.P.U. Bach* and the social hierarchies it observes and reproduces form a musical counterpart to the game franchise for which Sid Meier is best known, a resemblance that hints at a darker side to the ideological forces at work behind ludic techniques. As a global resource management simulation, Meier's *Civilization* encourages players to behave like Swift's Laputans by exerting colonial hegemony via the threat or enactment of violence in accordance with zero-sum game theory and the triggering of events that are at once under- and overdetermined.²⁵⁷ These machinations are themselves framed by an epistemological framework that registers identity, gender, class, and race via what Galloway describes as an "informatic mode of cybernetic typing" that relentlessly quantizes qualities in order to make them classifiable and processable within the operationally closed system of the game.²⁵⁸

For Galloway, *Civilization* flattens history in order to "[transcode it] into specific mathematical models."²⁵⁹ Such flattening has its own history, however. As a digital game based on a board game, *Civilization*'s genealogy can be traced back not only to the nineteenth-century *Kriegsspiel*, but also to the ludic deployment of stereotypes invoked by August Wilhelm Schlegel's description of the *commedia dell'arte*, in which "points of ... national character" are compared to chess pieces.²⁶⁰ This stacking of the algorithmic deck is isomorphic with the methods behind *C.P.U. Bach*'s typesetting of "German" allemandes, "Spanish" sarabandes, and "British" giges. In concert with *Civilization*, *C.P.U. Bach* reveals that the Bayesian playing out of the same foreseeably unforeseeable logical processes can calculate and simulate the rise and fall of empires, including arithmetical and geometrical equations, the passing of epochs, and even the optimal deployment of urban fortifications, as well as the real-time generation of music. But while this particular permutation of combinatorial functions can be found in Meier's digital games, it was contained and demonstrated more than three hundred years beforehand by the brown box of Kircher's *organum mathematicum*, which extended the algorithmic principles of the *arca musarithmica* and its *tariff* to all these domains (and more).²⁶¹

The remake of *Sid Meier's Pirates!* (Firaxis Games, 2004) further illustrates the ludomusical ramifications of this cybernetic reciprocity between epistemological mechanisms that are centuries removed from each other. In order to play the game successfully, would-be pirates must battle ships, besiege cities, engage in swordplay, and perform Baroque dances with governors' daughters in the hope of winning their hearts, thereby acquiring "amour" and "fame points" (Figure 52 and Video 6). If this last activity seems incongruous, that is reflective only of iconography; from a ludomusical standpoint, the asynchronous turn-based strategy



Figure 52. Screenshot from the remade version of *Sid Meier's Pirates!* (Firaxis Games, 2004).

Video 6. Dance gameplay from *Pirates!*, featuring the Menuetto from Handel's Sonata for Flute and Continuo in G, op. 1, no. 5, HWV 363b (transposed into E).
Reproduced courtesy of Justin G. Day.

To watch this video, scan the QR code above with your mobile device or visit
DOI: <http://doi.org/10.525/luminos.16.11>



of laying siege is the odd one out, since the other activities all rely directly on the player's successful demonstration of "timeliness, rhythm, or control."²⁶²

Pirates! performs a carnivalesque inversion of *Civilization* and the manipulation of weighted probabilities with which it unpredictably reinforces the ultimate inevitability of colonial hegemony of one kind or another. As a pirate with a backstory involving the abduction and enslavement of his parents by the nefarious Marquis de la Montalbán, the player engages in asymmetrical and illegal activities in ways that, like the *commedia dell'arte*, seem to undermine the hierarchical status quo while ultimately underlining it. The ancient Greek roots of the term "cybernetics," coined by Norbert Wiener in 1948 to describe self-regulating mechanisms, are linked to governors as well as helmsmen: both despite and owing to his nautical misdeeds, the game's optimal outcome sees the piratical protagonist retire as the governor of a Caribbean capital city.²⁶³

The dancing minigames in *Pirates!* both enact and represent the cybernetic process by which the player infiltrates a world of decorum and privilege in which success is only attainable by dutifully following the rules, enforced by the sovereign

authority of the CPU. Via the computer's keyboard, the player provides numerical feedback that corresponds to the gestures of the governor's daughter, as illustrated by the legend in the bottom right corner of Figure 52. In order to win her heart, which iconically swells and pulses at the top of the screen, the player must respond to increasingly lengthy sequences of gestural combinations in a timely manner and perform flourishes and pirouettes by matching rhythmic patterns that map precisely onto the metrical stresses of the accompanying bourrées and minuets composed by J. S. Bach and Handel, among others. "Dancing" thus entails the mechanical mimesis of embodied motion, the performance of a ludic protocol through which arbitrary movements (both at the keyboard and onscreen) assume "affective" significance.²⁶⁴

Just as C.P.E. Bach's *Einfall* and Geminiani's *Guida* can be understood both to echo and to anticipate the operations and social functions of other algorithmic phenomena, so can contemporary digital games such as *Pirates!*, *Civilization*, and *C.P.U. Bach* be understood as thoroughly historical. Although they plunder the archive for names, dates, iconographical details, and even the passing acknowledgment of cultural otherness, the historicity of such games has little to do with accuracy or verisimilitude. Paradoxically, it resides in the *very ahistoricity* with which they appropriate the past, reflecting an epistemological continuum that encompasses the digital means of arraying, permuting, and exploiting patterns of data connecting the numbered rods of Kircher's *arca musarithmica* to the pits that pockmark the spiraled valleys of *C.P.U. Bach's* CD-ROM.

In stark contrast to the evangelism of the utopian and apocalyptic rhetoric that suffuses so many accounts of algorithmic generation and artificial intelligence, the marginality of the ludomusical devices addressed in this Key testifies to the emergence of obsolescence, to the unforeseen consequences that condemn certain systems to neglect, entropy, and the brink of oblivion. Conceived as a "boutique" product that verged on a vanity project for Meier, the fate of *C.P.U. Bach* was sealed by the obscurity of its host platform, the 3DO, which failed to gain traction in the marketplace and was quickly abandoned by manufacturers, developers, and players. The failure of such systems bespeaks the withering of ludic connectivity, the absence of the interplay with their psychic, social, and communicational counterparts that would have sustained their conceptual and material currency. From this perspective, Kircher's *arca*, Bach's *Einfall*, Winkel's comptonium, and Meier's *C.P.U. Bach* all stand as media-archaeological relics in need of rediscovery, restoration, reconstitution, and emulation if their aleatoric operations are to be made to matter today.

Both despite and owing to these failures, the same types of ideas, dreams, and doubts concerning the playfulness of automated spontaneity have been consistently reaired, retested, rejected, reformed, and reformatted over the last four centuries. On the one hand, the segmental operations of the *ars combinatoria* offer the prospect of limitless variety when subjected to the laws of uncertainty; on the other, human observers are rendered helpless when confronted by what Jeremy Gilbert-Rolfe describes as the "blank and static activity, intelligence without

gestural expression, encoding without inflation or irregularity, pure measurement, and pure power” of the technological sublime, whether enacted by the comptonium or *C.P.U. Bach*.²⁶⁵ Furthermore, and eschewing hands altogether, the autoplating of *C.P.U. Bach*’s digitized harpsichord again brings to mind Diderot’s notion of a self-conscious “harpsichord with sensation and memory” that can “repeat by itself the tunes you play on its keyboard.”²⁶⁶ In the course of investigating the mechanical means by which the unexpected can (be contrived to) happen, individuals have been confronted with the proposition that they are at once laying bare and mystifying the very processes by which the self is constructed. As the locus of ludomusical activity moves from field of play to black box, the role of human agency shifts from player to observer to clueless outsider. Rather than Uexküll’s metaphysical vital sign, the invisible hand that glides over *C.P.U. Bach*’s keyboard is analogous to its sublimely indifferent counterpart, famously invoked by Adam Smith, that regulates the stable distribution of resources by apparently allowing individuals to behave *ad libitum* and *ex tempore* while imperceptibly loading the dice in favor of the historically determined status quo.²⁶⁷

And yet the rope that binds players might yet offer them a means of escape. These recursive and paradoxical dynamics prompt an ambivalence akin to Flusser’s equivocality toward extemporary play at the keyboard. While the selection of which key to press to continue might be unforeseeable to the extent that it can be freely made, we saw in Key 2–5 that Flusser qualified this liberty as a “programmed freedom,” a choice made “according to the regulations” that amounts to nothing more than the arbitrary reconfiguration of a sequence of bits.²⁶⁸ That notwithstanding, as we saw in Key 1–5, Flusser envisaged the improvised “chamber music” of the future both to depend on and to transcend the discrete limits and logical rules of the keyboard, which would be capable of giving rise to “the experience of being out of oneself, of adventure, of orgasm.”²⁶⁹ Even—or perhaps particularly—when one cannot control the unconscious, aleatoric, and technological mechanisms by which ludomusical information emerges, one can decide what, if anything, to make of it.²⁷⁰ In choosing whether and when to (re)act, the observer participates, making a difference that just might make a further difference.²⁷¹

At its most elevated, such an intervention might assume the ludic status of what Goehr defines as “improvisation *impromptu*,” a seizing of the kairotic moment when the chips are down to play a decisive move with audacity, élan, and perfect timing.²⁷² The frisson invoked by Goehr resonates with the *jouissance* of adventurous encounter that Flusser ascribes to his keyboard-tapping improvisers. While such intense moments are exceptional by definition, they can shed light on the more mundane contexts in which a keyboardist is simply considering the next move to make, a process defined by Goehr as “improvisation *extempore*.”²⁷³ In the terms of second-order cybernetic theory, the significance of both types of occasion emerges from the premise that information can be measured in terms of the

response it elicits as well as by the degree of unpredictability that can be verifiably transmitted.²⁷⁴ In this sense, information is itself performative as well as constative insofar as it does what it says, even if the consequences of such saying and doing are by no means indistinguishable—or even commensurable.

In historical terms, conceiving of improvisatory play as both a first- and a second-order cultural technique creates space for it to shuttle between the earnest belief in (im)providence (whether attributed to God, terrestrial rulers, nature, the computer, or dice) and the satirical skepticism of onlookers such as Swift, Hayes, and Burney (who could not observe how they themselves were generating a paratactic series of unforeseen variations on the same Laputan theme).²⁷⁵ Like play, improvisation resists ontological grounding: its identification relies on its being staged and framed as such. Rather than resorting to the rhetoric of restoration that has suffused so many musical attempts to reanimate the extemporized past, we might approach it under the rubric of playful simulation or reenactment. *Apprehending improvisation as a response as well as a call, a return as well as a serve, emphasizes its dialogical performativity alongside its reiterability in a way that challenges distinctions between action and reaction, engagement and observation.*²⁷⁶ By acknowledging the entangled reciprocity of these phenomena, we put ourselves in a position to investigate how the tallying of scores can amount not only to the logging of a work's informational content in a performable format, but also to the scripting of ludomusical adventures that take the keyboard as a point of departure and return.

High Scores: WAM vs. LVB

In 1786, Mozart returned to the Redoutensaal during the Viennese carnival season, this time robed as an Eastern mystic. Instead of performing a harlequinade, he distributed a text bearing the title “Excerpts from the Fragments of Zoroaster,” each copy of which contained eight riddles and fourteen proverbs he had devised for the amusement and edification of his fellow masqueraders.¹ In contrast to the profusion of equally viable possibilities produced by the rigid mechanisms of *Würfelspiele* and the *commedia dell’arte*, the ludic pleasure of riddles lies in the distillation of boundless possibilities into a singular solution via a series of statements cleverly designed to (mis)lead the reader, at once inviting and resisting the correct answer. Similarly, proverbs compress observations on complex patterns of behavior into an optimally efficient maxim. Both riddles and proverbs bear—or even necessitate—rereading: they rely on the capacity of the written word to store multiple layers of information and to prompt reflection before action. As indices of playful thought, Mozart’s “Zoroastrian” fragments thus stand in an analogous relation to the *canovaccio* of his pantomime as a puzzle canon to a *partimento*.² Yet despite their differences, all four phenomena rely on the staging of events that are both rule-bound and unexpected, even if their ludomusical elements are distributed, configured, performed, and heard quite differently.

In much of Mozart’s keyboard music, formal designs and narrative threads are at once projected and subsumed by sequences of events that evince what Holtmeier characterizes as a “certain accidental quality,” lending the impression that “something different could sound in their place.”³ In a similar spirit, Vasili Byros has explored counterfactual alternatives to Mozart’s syntactical and schematic (re)ordering of materials, linking the composer’s ludomusical strategies to his

penchant for anagrams, puns, and other forms of wordplay.⁴ Holtmeier and Byros engage in playful processes of imagining how Mozart's music might have emerged differently: Byros ascribes an awareness of such possibilities to the eighteenth-century listener, whereas for Holtmeier it arises directly from the hands-on activities of practice and memorization at the keyboard.⁵ For both, the sophistication of the particular forms in which Mozart's sonatas ultimately crystallized suggests that even when such contingencies are reverse-engineered from their neatly compiled notational code, they do not expose the mechanisms of Mozart's compositional methods so much as they pose further riddles to the performer, listener, or analyst.⁶

Today, the ludic currency of Mozart's music resides not only in the means by which its notes were strung together (a process of which the manuals of Riepel, Kirnberger, and Koch—not to mention the blind operations of *Würfelspiele*—can offer only the crudest of historico-cognitive hints), but also in the projection of sound, motion, and character from those notes. In other words, it has to do with performance as well as composition, and in particular with the musical score as an interface between the two that marks points of convergence and departure. Via readings (or rather playings) of scores by Mozart and Beethoven, this Key charts a course that tracks the ludomusical trajectories of notes and sounds. It focuses on continuities as well as disjunctions between historical, cultural, and material circumstances, issues of style, syntax, idiom, and idiolect, and the channels along which such factors were mediated and processed. This involves approaching scores from a range of perspectives that frame them as ideas, objects, charts, feedback mechanisms, and status indicators. *Accordingly, any given score might be treated as a provisional sketch, as a compositional proposition or declaration of intent, as a quasi-theatrical script to be realized in performance, as a set of rules for the player to follow (or break), as a chart that maps out musical terrain to be explored, or as the tallying of a ludomusical process that serves to quantify and record prior outcomes even as it continues to precipitate new ones.*⁷ A score can both script and record improvisatory operations in ways that blur boundaries between composition and performance, whether revealed by its fragmentary material state or inferred from the ends to which it might be put.⁸

These multiple functions reflect the variability of inscriptive fixity in both ideational and material terms. On the one hand, they relate to the shifting means and metaphors by which music could be ontologized, as Goehr demonstrates in her influential tour around *The Imaginary Museum of Musical Works*. On the other, they emerge from pragmatic considerations that place the history of musical style into direct contact with the formatting of the media by which it was stored and transmitted, which underwent momentous change over the course of the eighteenth century. In particular, the conception and fabrication of music in specific genres via the production of textual objects and the operation of keyboard

interfaces were intimately and reciprocally connected, as John Butt observes in his genealogical survey of the early keyboard concerto.⁹ Owing to the entrenchment of tablature and the prevalence of part-books as well as to the overwhelming identification of the keyboard with the *basso seguente* or *continuo*, the notion of writing an obbligato part for the right hand in concerted music appears to have gone unimagined before J.S. Bach, Handel, and Vivaldi independently experimented with it in 1707–08.¹⁰ By the end of the century, however, the proliferation of harpsichords, clavichords, fortepianos, and their scores had shown the keyboard to be a transcriptive medium capable of rendering every musical genre while carving out its own distinctive niche.¹¹

This process was enabled and sustained by the reciprocal mapping of notes and keys as concepts and objects, as discussed in Key 2–2. Beyond such one-to-one relationships, the social, industrial, and pedagogical dynamics through which the keyboard became the primary locus of improvisatory, performative, and recreative behavior help account for the formation of a canonical repertoire, a repository of musical code that could be processed via its standardized programming interface. The software components of this thriving digital ecosystem were enriched by the iteration and deprecation of branches, forks, and mergers by individual composers and arrangers, while its hardware was subjected to constant revisions at the hands of circuit-bending inventors, builders, technicians, and restorers. Their collective efforts amounted to the technical facilitation of musical play at the keyboard.

As suggested in Key 1–2, the ostensible anachronicity of such ludomusical analogies between historical keyboard performance and contemporary digital praxis can prompt us to consider the new in the old as well as the old in the new. In this light, it is telling that media archaeologist Erkki Huhtamo echoes musicological strategies for making sense of late-eighteenth-century instrumental music in forging “topical” connections between chronologically and culturally disparate phenomena that intersect with historical narratives at oblique angles.¹² Throughout this Key, such catachrestic maneuvers are undertaken in the interest of registering ludic aspects of musical performance that, virtually by definition, elude attempts to capture them in traditional scholarly parlance. That notwithstanding, they are grounded by the relative familiarity of the scores on display and the biographical and analytical modes in which they are presented. Approaching these scores in terms of the interactive play they occasion rather than the textual information they convey does not pretend to supplant time-honored modes of philological, analytical, and hermeneutical exegesis, but rather aims to supplement them.

In mapping out the ludomusical potential of scores considered as improvisatory prompts, compositional statements, performative instructions, and codifications of behavioral expectations, this Key resonates with tones struck by each of its predecessors. First, the ludomusical logic of *mimicry* allows us to conceive of how the musical past might have played out in terms of simulation or reenactment rather

than via obedient compliance with the strictures of *Werktreue* or the melancholy Romantic pursuit of lost objects and experiences. Second, the notion of the score in terms of its playful realization at the keyboard draws attention to numerical rather than alphabetical operations, which is to say it favors counting over recounting, showing over retelling, proceeding over describing, and the hand's musical digits over the mind's linguistic analogies. Finally, the improvisatory *partimento* tradition to which Keys 2–3 and 3–2 allude provides this Key with a red thread in the form of a cadential bass line—a *movimento* en route to a *clausula*—on which Mozart and Beethoven relied in the course of designing mechanisms by which ludomusical adventures might both draw to a close and get under way in the first place.

4-1 UNSETTLED SCORES

Musical repertoire and the musicological discourses entwined around it encipher and reflect audible phenomena as written signs. Owing in part to these communicative conditions, the dominant mode of Western music criticism has been hermeneutical, predicated on teasing meanings out of scores as if they were literary texts. Preambular disclaimers acknowledging and lamenting the unbridgeable gulf between word and sound rarely affect the tone or tenor of the exegesis that follows; on the contrary, they are baked into the logocentrism of Romantic discourse, which has long represented musical unrepresentability by assigning its resistance to symbolism a distinctive place in the symbolic order. By way of the “certificate of apprenticeship” both attributed and addressed to his fictional *Kapellmeister* Johannes Kreisler, Hoffmann devised a feedback loop that recursively ratifies its own criteria, amplifying the wondrous sounds of nature by way of the alphabetic technology that they purportedly evade and exceed: “Music . . . is the universal language of nature, speaking to us in beautiful, mysterious sounds, and we wrestle in vain trying to confine those in symbols; those artificial notes are no more than hints of what we have heard.”¹³ Even as the means, motives, technology, and terminology held to account for it have changed radically over time, this remainder has remained. Whether mapped as a buffer zone, plotted as an asymptotic boundary, or driven in as a wedge, it continues to (de)construct and mediate between the dyadic pairings of text and event, statement and delivery, meaning and presence, automation and liveness.¹⁴

Within recent scholarship, tensions between text-based investigations and inquiries into music's phenomenal emergence by way of performance have been productively registered across a range of disciplinary milieux. In his programmatic book *Beyond the Score*, Nicholas Cook sets out to historicize and to broaden the scope of musicological research by incorporating detailed considerations of roles played by improvisers, performers, listeners, and analysts that have been excluded or downplayed by the academic propensity to conceive of “music as writing.”¹⁵ Th

longevity of the paradigm by which scores have been not merely kept but obsessively preserved testifies to the tightly circular logic of its historical mediation—which is to say its mediated history. One symptom of this reciprocity is that, both despite and owing to Kreisler's complaints, the term "note" has come to signify both an inscribed instruction or invitation to produce a sound and the unit of musical sound itself. This synonymy is embedded in the archival and repertorial privilege granted to documentary traces over other forms of embodied, conceptual, and material evidence.¹⁶ To adopt Gumbrecht's elegant phrase, music in performance "undoes itself as it emerges."¹⁷ Conversely, music history deals almost exclusively with that which did or could not undo itself, whether by happenstance or design. From this perspective, "classical" music might be defined as the music that has proved to be the least undoable of all.

As Fred Moten notes, Adorno was an apologist for the notion that such music must defer and conceal its abject reliance on mimetic gesture, mediating the immediacy of its sensuous presence by aspiring to the atemporal and disembodied condition of inscription.¹⁸ Adorno thus calculated Kreisler's Romantic remainder in reverse. While grudgingly admitting the necessity of sonic enactment, he focused instead on the ludic process by which "hints" to its mysteries could be symbolized and concealed: "Every musical text is . . . a fundamentally insoluble riddle and the principle for its solution."¹⁹ To account for the legibility of such riddles, Adorno distinguished between "mensural" and "neumatic" notational elements, the functions of which become identifiable in specific idiomatic contexts.²⁰ To translate these terms into those introduced in Key 1–4, mensural notation is digital in that it denotes discrete quantities of musical information (primarily the melographic parameters of pitch and rhythm), while neumatic notation is analogical in that it connotes gesture, phrasing, and structure by way of mimetic vectors. In making this distinction, Adorno relocated the dialectic between compositional inscription and the spontaneous performance of mimesis to the score itself, which betrays the technical and gestural means of its own production. Mensural precision at once surpasses and falls short of the smooth contours of the neumatic, which in turn relies on jagged mensural quantizations even as it defies them.

In Adorno's reading of Hugo Riemann's *Handbuch der Musikgeschichte*, the relation of the neumatic to the mensural shifted decisively at particular historical junctures.²¹ The origins of neumatic notation were to be sought in cheironomic accents and gestures that had little to do with the unambiguous fixing of melodic content, but rather ensured that the contours and stresses of the chanted text were properly acknowledged. It was in this light that Adorno traced the concept of mensural notation writ large not merely to the development of symbolic technologies for specifying durational proportions, but also to the Guidonian gridding of pitch, both of which provided an unprecedented degree of specificity as well as autonomy from what he saw as the baleful influence of text and its ritual performance.²² In a Weberian vein, Adorno measured the rise of mensural notation and its concomitant rationality via

the “pure numbers” of figured bass; neumatic elements, conversely, could be inferred from the parabolic beams and ligatures of autograph scores indexing the sweep of the composer’s hand as it cursively inscribed mensural information.²³ On occasion, however, numerical symbols could represent neumatic instruction rather than (or as well as) mensural signification, as Adorno noted of the fingerings that connote and choreograph the quasi-cheironomic gestures of a pianist’s left hand plunging into Beethoven’s Sonata in C minor, op. 111 (181–22):²⁴

In nineteenth-century scores, neumatic inscriptions typically took the form of idealized, gnomic, or ambiguous indications, literal remnants from which the spiritual gist had to be divined. They were materialized via an ever-expanding lexicon of expressive symbols and instructions—primarily to do with agogics, dynamics, articulation, and the Aeolian modulator of the sustaining pedal—that probed and blurred the boundaries between melographic and oscillographic forms of representation.²⁵ For Romantic observers, hairpins and other neumatic squiggles served as vital signs to which compositional agency and Hegelian subjectivity could be ascribed. At the same time, however, they were contiguous with the phonautography of Scott de Martinville, who offloaded the Kreislerian burden of transcribing and cataloging nature’s “universal language” back onto its disembodied author: “It is a matter, as you see, by this new art, of forcing nature herself to constitute a written general language of all sounds.”²⁶

As noted in Key 2–2, Scott’s emphasis on phonautography as sonic self-writing seems bizarre from the post-Edisonian perspective that figures it primarily in (re)sounding terms. It nonetheless sheds light on Adorno’s claim that “through the curves of the needle on the phonograph record, music approaches decisively its true character as writing,” while the autographic notion of text that writes itself illuminates his anti-Hegelian thesis that “the dignity of the musical text lies in its non-intentionality.”²⁷ Automatically playing out what Adorno analyzed as the zero-sum endgame of sonic reproduction, the phonograph needle mimicked the musician by performing the neumatic mimesis of a no-longer-existent original.²⁸

In the archaeological terms of the digital analogy, the mediation of the inscriptive techniques noted by Riemann and Adorno can be considered independently of their teleological and eschatological historicism.²⁹ This involves recognizing functional as well as chronological continuities and distinctions: In part or in whole, can a given score be apprehended as prescription or transcription, prompt or aide-mémoire, *canovaccio* or script, chart or blueprint, recipe or autopsy? Depending on how scores are embedded in specific improvisatory, performative, reproductive, and analytical procedures, the balance between mensural, neumatic, and idiomatic elements may be struck differently.

The process of suturing them is on display toward the conclusion of an “unmeasured” prelude in G minor as anonymously notated in the Bauyn Manuscript (ca. 1690) and attributed to Louis Couperin (Figure 53, Audio 6). The prelude is cast in a tripartite form redolent of the Italo-German toccata; as Davitt Moroney points out, the outer two sections are “rhythmically free while the central one is contrapuntal.”³⁰

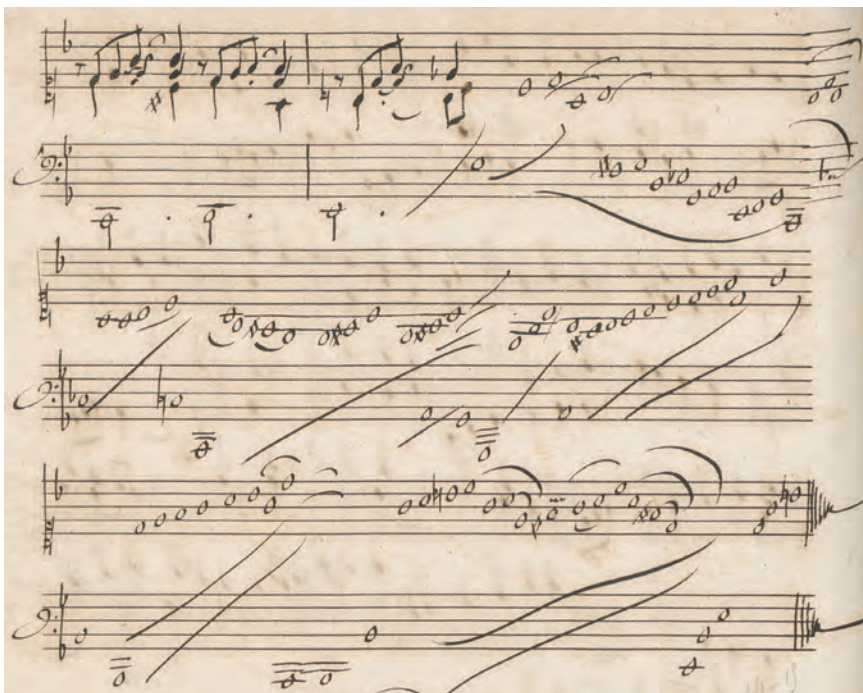


Figure 53. Louis Couperin (attrib.), conclusion of Prelude in G minor (ca. 1658), Bauyn MS (ca. 1690), Bibliothèque nationale de France (Rés. Vm7 674–75), 2 vols., 2:14. Reproduced by permission.

Audio 6. Couperin, conclusion of Prelude in G minor, performed by Matthew Hall.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.12>



Whereas the imitative rigor and sharply defined rhythmic profile of this dance-like central section demand mensural specificity, its passage into the prelude's neumatic conclusion is staged in a precisely vague manner. On the one hand, this transition can be read as a gradual slackening—even an entropic dissolution—of composely and inscriptive control; on the other, it signals a reciprocal increase in the performer's latitude to make of the passage what (s)he will. Yet this freedom is by no means absolute: while the spacing of the notes and the lines that signify slurring, grouping, prolongation, and ornamentation might not convey quantifiable information, they nonetheless hold qualitative and relational implications for their delivery in the *style brisé*.³¹ In this regard, unmeasured notation is less about the absence of bar lines than about representing the desynchronized flow of musical events in performance by inscriptive means that supplement and undermine the tallying of discrete pitches and rhythms.

In Butt's terminology, the prelude's notation qualifies as "purposely incomplete."³² As with a *partimento* bass line, players could pick up the unwritten rhythmical and metrical clues that lay behind such notation by way of instruction, study, and the intertextual accumulation of experience. The prelude's "imprecision" was not a deficiency, but rather a regulative attribute from which all necessary information for realization could be inferred—if only at the hands of a (budding) professional. As Moroney puts it, such preludes themselves teach students about the harpsichord's possibilities "through [the] fingers," reinforcing the idea that we might conceive of performance at the keyboard not primarily in relation to the literal or oral transmission of information, but as a fundamentally manual and digital activity.³³ This approach is endorsed by the genre and function of the prelude, its purpose of probing the qualities and limits of a particular instrument and its tuning, its association with imagination and fancy, and its flexible modularity vis-à-vis other music to be improvised, played, written, or heard alongside it. Opening up a channel between player and instrument, the prelude establishes a feedback loop that also forms part of a larger network. The harpsichord mottoes discussed in Key 2–3 can be read in this light: by envoicing instruments, they attribute a degree of agency that recognizes the capacity of the keyboard both to resist and to yield, to obey and to defy, to frustrate and to inspire, to enter into dialogue—in a word, to play.

If the scores of Couperin's unmeasured preludes mark both the outcomes and the potential of ludomusical play conducted in line with these tacit principles, then their counterparts published by Jean-Henri d'Anglebert in 1689 explicitly codify the rules of engagement. Whereas the manuscript copies of Couperin's preludes were clearly not suitable for broad dissemination, d'Anglebert aimed to reach an audience beyond his professional colleagues. Somewhat wishfully, he thought that this kind of specialized musical knowledge could be effectively transmitted via the printed letter and note, so long as the presentation of each were sufficiently clear and detailed. To that end, d'Anglebert bookended his fastidiously engraved *Pièces de clavecin* with a tabular glossary of ornaments and a brief do-it-yourself guide to the correct deployment of intervals, chords, cadences, and harmonic successions.

To facilitate the conception and execution of his preludes, moreover, d'Anglebert imbricated the neumatic and the mensural by setting flagged or beamed black notes, which indicate melodic fragments in the musical foreground, into relief against a harmonic backdrop delineated by white notes à la Couperin, as illustrated in Figure 54 (Audio 7).³⁴ Anachronistic though the comparison might be, the notational parallax induced by d'Anglebert's black and white notes brings his perspectival musicography into oblique contact with Schenker's.³⁵ In this connection, the Schenkerian principle of reduction is less relevant than the reciprocal relationship between the elaboration and the derivation of foreground and background by way of a schema—be it an (un)figured bass line, a Fuxian gambit, Riepel's *monte*, Schenker's *Ursatz*, or Gjerdingen's "Meyer"—revealed in the course of its realization.³⁶ In Luhmann's terms, schemata are akin to ludic rules insofar as they neither "force repetitions to be made [nor] specify action," but operate as "limitations to flexibility which make flexibility within



Figure 54. Jean-Henri d'Anglebert, excerpt from Prelude from Suite in D minor, *Pièces de clavecin* (Paris: d'Anglebert, 1689), 69. Reproduced by permission of the Bibliothèque nationale de France.

Audio 7. D'Anglebert, excerpt from Prelude in D minor, performed by Matthew Hall.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/kuminos.16.B>



prestructured barriers possible in the first place.³⁷ Inscriptions of such schemata serve both as launch pads for musical creation and as resting places for its remains. Their symbolic mediation testifies to the nondiscursive means by which music can be at once projected into the future and retrospectively grasped by the fingers.

The notion that the unmeasured analytical chart of a piece might relate to its score in an analogous manner to that in which d'Anglebert's notation gestures toward its actualization is corroborated by Schenker's enthusiasm for improvisation.³⁸ For Schenker, even large-scale formal design could be understood as improvisatory: "The masters . . . were able to traverse the path of the exposition with giant strides, as if improvising, creating thereby the effect of a dramatic course of action."³⁹ This helps account for Schenker's admiration for C. P. E. Bach's "gift of sounding spontaneous—*das Ewig-Improvisierte*," on the one hand, and Riepel's proto-Schenkerian notation of a phrase and its various "expansions, contractions, and transformations," as Joel Lester describes them, on the other.⁴⁰ From such a perspective, analysis reverse-engineers improvised utterances and vice versa, revealing the reciprocity between preludic prescription and analytical transcription that underpins Czerny's advice to Miss Cecilia, worth quoting here once more: "you know that all music may be reduced to simple chords. Just so, simple chords conversely serve as the ground-work on which to invent and play all sorts of melodies, passages, skips, embellishments, &c."⁴¹

*A ludomusical approach to the play of performance neither reifies the score nor self-consciously applies information knowledge gleaned beyond its confines, but rather acknowledges how text and praxis are systemically interwoven.*⁴² Biographical histories, psychological tendencies, physiological tics, repertorial familiarity, idiomatic comfort, and the demands of any given instrument can all feed into performance as a phenomenon that is improvisatory (in that it issues directly from a specific and unique occasion) and analytical (in that it cannot help but articulate—and make articulable to others—the premises on which it is founded).⁴³ Just as rules guide the

form taken by the playing of a game without determining—or even fully describing—it, so musical inscriptions play important roles in regulating musical behavior without necessarily prescribing, proscribing, or otherwise accounting for it.

While scores may be kept, they are rarely settled. Amid the word's tangled etymological network, "to score" is associated with provisionality, with the marking of a dotted line that might be traced or severed in the future. In Figures 53 and 54, this contingency has itself left a trace that serves to index the presence of history and the history of presence, but it is futile to imagine that these qualities can be recovered: as Daniel Leech-Wilkinson plainly states, "music is not transmitted from the more distant past. Only notation survives."⁴⁴ Coming to terms with this hard truth entails bypassing the Romantic dialectic of fetishism and nostalgia that interprets old scores as symbols of loss and abandoning any residual faith in positivistic, technological, and shamanistic promises to channel—even to redeem—the past. In their stead, a number of ludomusical strategies present themselves. We might construe performance from seventeenth- and eighteenth-century scores as playful simulation rather than the authenticistic rendition of an imagined past, as the subjunctive modeling of a process rather than the rehearsal of an overdetermined outcome, and as an infinitely extensible array of reenactments rather than a series of doomed attempts at resuscitation.

While such ludomusical approaches partially reflect the epistemological and cultural orientations of contemporary digital games, as will be made explicit in Key 5, they are also in tune with the two excerpts quoted above, and in particular with the various forms of openness and uncertainty they exhibit. On different spatiotemporal levels, both feature a schematic pattern that propels the music toward a cadence and yet invites—even requires—the collusion of composer, score, and player for the process to play out. Common coin in the syntactical currency of tonal music, this pattern was known and taught in the Neapolitan *partimento* tradition as the *cadenza composta di salto* ("leaping compound cadence"): three archetypal forms identified by Diergarten are shown in Example 2.⁴⁵ Starting midway through the second system of Figure 53, an iteration of the *cadenza composta di salto* closely related to the third variant illustrated in Example 2 brings Couperin's prelude to a close by way of a stepwise 3–4–5 ascent in the bass that culminates in the unfurling of 6/4–7/5/3 harmonies before the final *tierce de Picardie*. Despite substantial differences in tone, affect, and function, the same type of *cadenza* is underscored



Example 2. Three forms of the *cadenza composta di salto*, reproduced from Felix F. Diergarten, "Beyond 'Harmony,'" 67.

by d'Anglebert's bar line in Figure 54 (which performs a structural rather than a metrical function).

Although the closural function of such *cadenze* was more utilitarian than playful, their ubiquity gave rise to forms of embellishment and extension that led both to the development of the full-fl dged *cadenza*, which served as a showcase for the performer's virtuosity and ingenuity, and to a range of cadential *inganni*, ludic deceptions that played on the expectations of performer and listener alike.⁴⁶ Especially when displayed in the major key, these attributes aligned the function of the *cadenza composta di salto* with that of the *lieto fine* by signaling, suspending, and ultimately delivering the sense of a comic ending. In sonatas as well as concertos, as we shall see, Mozart and Beethoven took full advantage of these implications in order to defer, disguise, subvert, and delight. From a score-keeping perspective, however, the significance of these unassuming schematic patterns lies in their potential to rewire the literary and historical short circuit that infers improvisatory or performative play from notation—even *manquée* or *sous rature*—and thus embalms rather than revives it. While the *cadenza composta di salto* is eminently scorable, it cannot be defined or circumscribed by any single inscription. Propagated by the diffusive operations of memory, digits, keys, *partimenti*, and even the paper machinery of *Würfelspiele*, it circulated widely via storage media, mechanisms of retrieval, techniques of invention, and modes of representation.⁴⁷ As a result, attempts to account for the performative power of the *cadenza composta di salto* can neither resort to hermeneutical forensics, under the scrutiny of which it is easily (dis)counted as mere convention, nor take cover under the rubric of Kreislerian ineffability, Gadamerian *Volzugs Wahrheit*, or Austinian utterance.⁴⁸ Instead, they have to come to grips with its continual (re)making, with the constant processes of iteration, adaptation, and transformation that have kept it in play.

4-2 MOZART'S TWO-PLAYER GAMES

Traveling under aliases, or going by no name at all, the *cadenza composta di salto* made its way across Europe over the course of the seventeenth and eighteenth centuries. As a fundamental articulator of musical syntax, it crossed stylistic and generic as well as national and linguistic boundaries. Its appearance in French unmeasured preludes and Neapolitan *partimenti* suggests a ludomusical mapping between the variability of its skeletal notation and the freedom with which it could be realized at the keyboard. This is made implicitly explicit by its twofold appearance within the *Gerippe* of the fantasia with which C. P. E. Bach concluded his *Versuch* (Figure 21).⁴⁹ Although the bottom-up conception of Bach's fantasia is figured in accordance with Italo-German thoroughbass tradition, its (un)measured balance of form and freedom resonates with that of the prelude as defined by François Couperin in *L'art de toucher le clavecin* (1716):

A prelude is a free composition in which the imagination gives rein to any idea which presents itself. But it is rather rare to find geniuses capable of producing them on the spur of the moment, and so those who resort to these non-improvised preludes should play them in a free and easy style, not adhering too closely to the exact rhythm.⁵⁰

In a similar vein, Rousseau wrote of the delightful freedom granted by preludes, whether extemporized or composed, from “subservience to the rules that critical eyes impose on paper.”⁵¹

These Bachian, Couperinesque, and Rousseauian attributes were absorbed by Mozart, who dispatched a prelude to his sister Nannerl from Paris in 1778 with the following disclaimer:

The manner of playing it I leave to her own feeling. This is not the kind of Prelude which passes from one key into another, but only a sort of Capriccio, with which to try a clavier. . . . You need not be very particular about the time. This is a peculiar kind of piece. It’s the kind of thing that may be played as you feel inclined.⁵²

While this prelude has been lost, the capricious qualities described by Mozart are on conspicuous display in another written to Nannerl’s tonal specifications the previous year (K. 284a, the ending of which is reproduced in Figure 55 and can be heard in Audio 8).⁵³ In the manner of Louis Couperin’s Prelude in G minor (Figure 53), this prelude interleaves measured imitative sections with two “free” sections that lack bar lines (but not flags and beams). The first of these latter sections is marked “Capriccio,” advertising its playfully disruptive function. Despite the *ilinx* of their whirling arpeggios and broken chords, however, both episodes conform to the *ludus* of harmonic protocol, as Robert D. Levin demonstrates by way of an X-ray that exposes the prelude’s Bachian *Gerippe*.⁵⁴ The first passage alternates hands and registers in sequentially exploring all three diminished seventh chords, sonorities specifically recommended by Bach for the generation of free fantasias, before clinching the modulation to B flat major that Nannerl had stipulated.⁵⁵ After the opening motive has been subjected to imitative treatment in the second measured section (the third and fourth systems of Figure 55), the final free section is at once a *cadenza composta di salto* and a miniaturized *cadenza* proper: the functional synonymy of the two terms is flagged up by Mozart’s 6/4 figuring, but masked by the grandiloquence of its realization (which is in turn wittily punctured by the isolated understatement of the dominant seventh chord that precedes the flamboyant final flourish).⁵⁶

Insofar as he could readily improvise such preludes, Mozart would have qualified as one of François Couperin’s “rare geniuses.” The scoring of this one can thus be attributed to Nannerl as well as to Wolfgang, for it would never have been written without her. Crafted in response to a specific request, the texture of its modulatory fabric testifies to the intimacy of a dialogical relationship between the two that could be remotely performed at the keyboard as the sharing of embodied experience. As an epistolary transmission, this score served to span the distance that separated brother from sister.



Figure 55. Mozart, autograph score of Modulating Prelude from C to B flat, K. 284a (1777), fol. 1v–2r Reproduced by permission of the Pierpont Morgan Library, New York (Cary 210).

Audio 8. Mozart, conclusion of Modulating Prelude from C to B flat, performed by Roger Moseley (fortepiano after Johann Andreas Stein [1784] by Thomas McCobb [1972]).

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.4>



On different levels, dialogical dynamics also arise from the prelude's play between left and right hands and from its manipulation of disparities between implication and realization. As proposed in Key 3–2, this type of ping-pong profoundly and multifariously informs Mozart's music. Beyond the immediate pleasures of ludomusical back-and-forth, however, the myriad forms of Mozartian dialogue enumerate the rules that tacitly regulated them. As his exchanges with Nannerl imply, these rules have to do with cultural protocols governing the performance of gender as well as scores. On their tours of Europe in the 1760s, both Wolfgang and Nannerl were celebrated as *Wunderkinder*; the fact that Nannerl did not acquire the ability to improvise fluently perhaps had less to do with her

potential to do so than with the professional trajectory that Leopold plotted for Wolfgang but denied her by ignoring her compositional ambitions, curtailing her public performances when she reached the age of eighteen, and obliging her to perform onerous domestic duties thereafter.

In this light, the game of *mimicry* that Nannerl played with the lost prelude her brother sent her in 1778 is imbued with a poignant tone. On its arrival, she immediately memorized it and passed it off as her own invention, to Leopold's amazement when he returned home an hour later:

She told me that she had made up something and would write it down if I liked it. She began to play the first page of your prelude by heart. I stared at her and exclaimed: "Where the devil have you got those ideas from?" She laughed and pulled the letters out of her pocket.⁵⁷

The liberty taken by Nannerl was in line with that which Wolfgang had urged her to exercise by playing the prelude "as you feel inclined" and in accordance with "her own feeling."⁵⁸ But although Nannerl had playfully staged a scripted process as an improvisatory event, her harmless deception suggests how a score might be written down to register the result of such events, tallying and recording noteworthy outcomes.

While the epistolary medium of Wolfgang's collaboration with Nannerl afforded asynchronous play in that its dialogue had to be scripted and performed in different times and places, the ambiguous state of a good deal of solo writing in the autographs of keyboard concertos indicates that Mozart often shuttled rapidly between prescriptive and transcriptive scoring, particularly where the fortepiano was concerned.⁵⁹ This was borne out by his collaboration with the renowned violinist Regina Strinasacchi, who aroused his admiration when passing through Vienna on tour in 1784: "she is a very good violinist, has excellent taste and a lot of feeling in her playing.—I'm composing a Sonata for her at this moment [K. 454] that we'll be performing together Thursday in her concert at the Theater [am Kärntnertor]."⁶⁰ The fact that this letter was written mere days before the concert, which was to be attended by Joseph II among other luminaries, conveys a degree of creative pressure applied by temporal proximity. While Mozart often found (or placed) himself in such situations, in this case the pressure was so intense that the full score seems to have failed to materialize by the time of the performance: according to the recollections of Mozart's widow Constanze, the emperor himself noted with surprise that the composer's part contained nothing but blank staves.⁶¹ The autograph of K. 454 reveals that the violin and keyboard parts were notated in different ink, indicating that Mozart did indeed write Strinasacchi's part first before squeezing in his own at a later date.

In many ways, the circumstances under which K. 454 emerged are analogous to those surrounding the genesis of the Sonata for Keyboard and Violin in G, K. 379/373a, which Mozart hastily conceived the night before a concert he gave with the violinist Antonio Brunetti and the castrato Francesco Ceccarelli in 1781. Mozart composed the sonata "between 11 and 12 o'clock . . . —but in order to get done in time I wrote

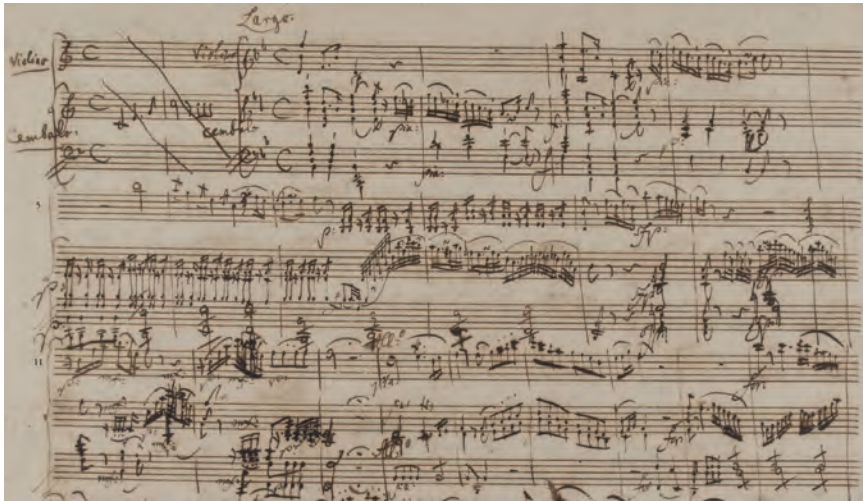


Figure 56. Mozart, autograph score of Sonata for Keyboard and Violin in B flat, K. 454 (1784), i, mm. 1–8. Reproduced by permission of the Stiftelsen Musikulturens Främjande (The Nydahl Collection: www.nydahllcoll.se). CC BY-NC-ND 4.0.

Audio 9. Mozart, Sonata for Keyboard and Violin in B flat, K. 454, i, mm. 1–8, performed by Roger Moseley (fortepiano after Johann Schantz [ca. 1795] by Thomas and Barbara Wolf [1991]) and Ariana Kim.



To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/huminos.16.5>

out only the violin part (*accompagnementstimm*) for Brunetti and kept my own part in my head.⁶² On this occasion, however, Mozart's cavalier attitude toward Brunetti and the circumstances of performance reflected a degree of disdain for the violinist as well as his brewing frustration with the quasi-feudal terms of his indenture to Prince-Archbishop Hieronymus von Colloredo.⁶³ The opportunity presented by his collaboration with the Stradivarius-wielding Strinasacchi was of a different order. As Samuel Breene notes in his imagining of K. 454 in the cultural and historical context of its first performance, Strinasacchi's compelling presence as conspirator, interlocutor, foil, and even rival must have elevated Mozart's game, lifting it far beyond the generic norms of the accompanied sonata (in which the nonkeyboard instrument was as often *ad libitum* as it was *obbligato*).⁶⁴ In the case of K. 379/373a, Mozart's description of Brunetti's part as "the violin accompaniment" reflects not only this tradition, but also the leading role played by the fortepiano in establishing and shaping the discursive terms of all three movements. Conversely, the equality of the two instruments in K. 454 is immediately evident from the stately exchanges with which the sonata opens (Figure 56, Audio 9): by way of elegantly choreographed gestures, each assumes and cedes the spotlight in turn.⁶⁵

Whereas Mozart claimed to have composed K. 379/373a beforehand, to have reproduced his own part from memory at its initial performance, and subsequently to have transcribed it, the revisions he made to Brunetti's part as well as the emendations he made to the keyboard part in the course of scoring it indicate that the different phases through which the work was conceived, sketched, and played prior to its definitive notation amounted to a dynamic iterative process. This complicates the notion, popularized by Mozart's preternatural (if often apocryphal) feats of memory, that "he copied the music from an imaginary score which he knew by heart," as Erich Hertzmann envisaged the means by which the overture to *Don Giovanni* was composed.⁶⁶ Conversely, the quick-fire dialogue between fortepiano and violin that unfolds throughout K. 454 emerges not only from the systematic rotation of musical material, but also from its readily comprehensible schematic backdrop, the structural principles of which can be inferred from the violin part alone when conceived as a "fundamental soprano," a *chant donnée* providing a *Gerippe* in the Tartinian manner of an upside-down *partimento*.⁶⁷ This implies that rather than mentally composing a keyboard part to be digitally reproduced in the course of performance, Mozart might have initially sketched the score of K. 454 as a musical *canovaccio* to be realized in collaboration with Strinasacchi via an improvisatory back-and-forth akin to Gherardi's dialogical play with his fellow actors in the *commedia dell'arte*—not to mention Mozart's own pantomimic play in the Redoutensaal the previous spring.⁶⁸

Although such a tour de force might seem implausible, a Viennese precedent for the extemporized generation of a sonata for keyboard and violin had been established by Karl Ditters von Dittersdorf and his hapless brother, who did not have an appropriate score to hand when called upon to perform such a piece by their patron Prince Joseph Friedrich von Sachsen-Hildburghausen.⁶⁹ While pretending to read the score of a symphony in E flat, the two managed to produce a barely adequate sonata in G by the skin of their teeth: placing their accomplishment in the context of the *commedia dell'arte*, Gjerdingen observes that the super Dittersdorf brothers "must have ably connected a string of well-learned musical schemata to form a seemingly spontaneous and continuous musical performance."⁷⁰ Owing to her training in composition as well as performance at the famed Ospedale della Pietà in Venice, Strinasacchi may well have been equipped to perform a similar feat, and was certainly qualified to engage with Mozart throughout the ludomusical process of bringing their sonata to life, no matter when or how it was scripted.

From this perspective, it is telling that the Largo introduction to the first movement of K. 454 takes shape from the dialogical fleehing out of a series of paired schematic elements. After the formalities of an initial inquiry and rhyming reply in the syntactical form of a variant of Gjerdingen's "Meyer" schema (mm. 1–4), a pulsing accompaniment and gracefully descending melody, redolent of the famous Adagio from Mozart's Serenade in E flat, K. 361/370a, outline an elaborate twofold *cadenza composta di salto* (mm. 5–9) before a repeated *clausula vera* on the dominant (mm. 9–11), echoed by a trio of *clausulae perfectissimae* that

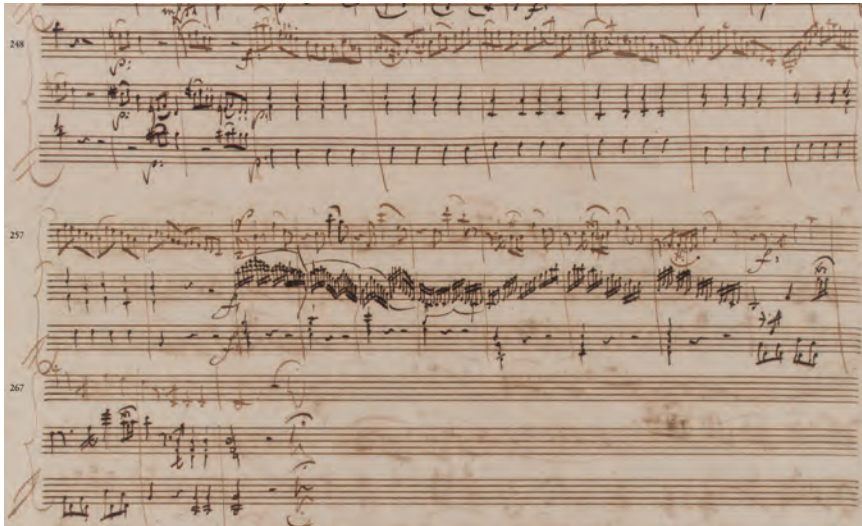


Figure 57. Mozart, autograph score of Sonata for Keyboard and Violin in B flat, K. 454, iii, mm. 248–69. Reproduced by permission of the Stiftelsen Musikkulturens Främjande (The Nydahl Collection: www.nydahllcoll.se). CC BY-NC-ND 4.0.

Audio 10. Mozart, Sonata for Keyboard and Violin in B flat, K. 454, iii, mm. 249–69, performed by Roger Moseley and Ariana Kim.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.16>



intensify the sense of anticipatory stasis (mm. 11–B), heralds the launch of the movement proper (m. 14f.).⁷¹

Even the nimblest pursuit of schematic strategies in real time cannot be held to account for the sonata's meticulously sculpted detail, its taut formal design, and its most audacious harmonic maneuvers.⁷² The fact that Mozart's score was incomplete at the time of performance did not preclude its capacity to represent precise instructions as well as broad implications that had been worked out in advance, explicitly for Strinasacchi and implicitly for Mozart himself. That notwithstanding, the passages that frame the sonata as a ludomusical event evince a particular openness to the exigencies and opportunities of extemporized conduct. Just as the leisurely pace and preambular rhetoric of the first movement's introduction afford a degree of improvisatory latitude, so the conclusion of the finale (Figure 57, Audio 10) encourages each player to outdo the other. With the finish line in sight, violin and forte-piano take turns to perform a virtuosic sequence of vaults and tumbles down the home stretch before collegial decorum leads them to break the tape hand in hand.⁷³

As in the introductory Largo, the sonata's ending relies on the schematic foundation of a twofold *cadenza composta di salto* (mm. 255–58 and 263–66). Here, however, each iteration has been at once necessitated and called into question by

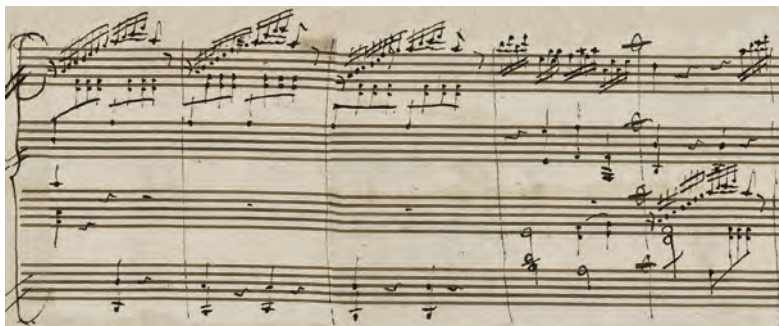


Figure 59. Mozart, autograph score of Sonata for Two Keyboards in D, K. 448/375a (D781), i, mm. 9–13. Reproduced by permission of the Kunstsammlungen der Veste Coburg (<http://www.kunstsammlungen-coburg.de/>).

Audio 11. Mozart, Sonata for Two Keyboards in D, i, mm. 1–33, performed by Shin Hwang (fortepiano after Johann Schantz [ca. 1795] by Thomas and Barbara Wolf [1991]) and Roger Moseley (fortepiano after Johann Andreas Stein [1784] by Thomas McCobb [1972]).



To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.17>

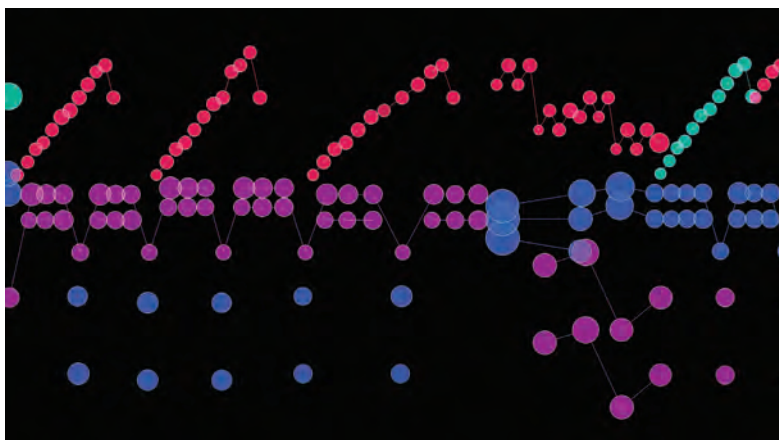


Figure 60. Screenshot from “Mozart, Sonata for Two Pianos, K. 448, first movement” (2015), mm. 9–B, visualized by Stephen Malinowski and performed by Paavali Jumppanen and Elaine Hou ([youtube.com/watch?v=74Osn05UkU0](https://www.youtube.com/watch?v=74Osn05UkU0)). Reproduced courtesy of Stephen Malinowski (<http://musanim.com/>).

Video 7. “Mozart, Sonata for Two Pianos, K. 448, first movement,” mm. 1–80, visualized by Stephen Malinowski and performed by Paavali Jumppanen and Elaine Hou ([youtube.com/watch?v=74Osn05UkU0](https://www.youtube.com/watch?v=74Osn05UkU0)). Reproduced courtesy of Elaine Hou, Paavali Jumppanen, and Stephen Malinowski (<http://musanim.com/>).



To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.18>

virtuosity of the Sonata for Two Keyboards has itself been damned with faint praise on account of an imputed shallowness that, for Arthur Hutchings, betrayed its confinement within the bounds of the *galant* style.⁷⁹ As with K. 454, however, the markers of *galanterie* that saturate K. 448/375a can be construed not merely as the trappings of convention, but as the rules and mechanisms of four-handed play that unfolds both sequentially and simultaneously. With Schillerian ardor, Alfred Einstein marveled at

the art with which the two parts are made completely equal, the play of the dialogue, the delicacy and refinement of the figuration, the feeling for sonority. . . . [Th s] apparently superficial and entertaining work is at the same time one of the most profound and most mature of Mozart's compositions.⁸⁰

A degree of spatiotemporal ambiguity is evident right from the opening measures (Figure 59, Audio 11): although they are presented in sequence by both keyboards *all'unisono*, the fanfares of mm. 1–2 and 3–4 could just as easily be overlaid. Either way, they provide a double entry in keeping with the duality of the good-natured repartee to come. Throughout the sonata, the principles of alternation, rotation, and cooperation are pursued with scrupulous fairness. On the one hand, this guarantees a high degree of formal balance and symmetry, Mozartian attributes hailed by Romantic and modernist evaluative strategies alike; on the other, it simply indicates that each player has the same responsibilities and opportunities in relation to the other, ensuring that their rivalrous collaboration (or collaborative rivalry) can be judged in the course of its emergence, which reflects directly on their relative performances as well as on the tenor of Mozart's script.⁸¹

The sonata's D-major effervescence and the exhilaration occasioned by the navigation of its scalar plumes and frothing arpeggios evoke the overture to the *Le nozze di Figaro* as well as the Keyboard Concerto in D, K. 451 (1784). But the range of dialogical dynamics projected on either side of its crystalline axis of symmetry is singularly profuse: players take turns to propose and respond, to thrust and parry, to observe and comment, and even to "wink" conspiratorially at the audience.⁸² These different forms of coplay, counterplay, and instant replay both account for and rely on the spatiotemporal rigidity of the sonata's formal and contrapuntal design.⁸³ The hard edges articulating such modularity might appear as the artificial remnants of *galant* mannerisms when framed by the tendrils of Hutchings's organicist assumptions. For Mozart's ludomusical purposes, however, they provided the requisite clarity for his choreography of temporal formalities (repeats, returns, refrains, and recapitulations) and the spatial patterning of lines and figuration (governed by the contrapuntal logic coordinating the motion of independent voices). As Hermann Abert noted in relation to the eighteenth-century "delight in playful gestures," Mozart's elegant forms are at once traced and elaborated by figures set in graceful motion.⁸⁴

These qualities come to the fore in Stephen Malinowski's melographic representation of the movement as recorded by Paavali Jumppanen and Elaine Hou.⁸⁵ Within the parameters of Malinowski's piano-roll-like Music Animation Machine,



Figure 61. Mozart, autograph score of Sonata for Two Keyboards in D, iii, mm. 272–307. Reproduced by permission of the Kunstsammlungen der Veste Coburg (<http://www.kunstsammlungen-coburg.de/>).

Audio 12. Mozart, Sonata for Two Keyboards in D, iii, mm. 278–329, performed by Roger Moseley and Shin Hwang.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/uminos.16.8>



the sacrifice of Mozart's autographic immediacy yields a dramatic gain in topographical clarity. A comparison of mm. 9–13 as represented in Figures 59 and 60 reveals how the Music Animation Machine transforms scales into ladders, dialogical exchanges into games of tag and catch, and the movement as a whole into a ludomusical playground (Video 7). Despite its ostensible anachronicity, moreover, this mode of melographic representation would have been known to Mozart owing to his familiarity with mechanical organs: Emanuel Winternitz reports that Mozart was able to plot music conceived for such an instrument by “drawing the pins just as they ought to appear on the surface of the barrel.”⁸⁶

It is surely no coincidence that the arbitrary caprice of Mozartian modularity is never more evident than on the ludomusical stage set by the breathless overture to *Così fan tutte*, the unsentimentally promiscuous combinatorial logic that anticipates the Marivauxesque games of seduction and deception to follow.⁸⁷ Throughout the finale of the Sonata for Two Keyboards, passages such as mm. 17–24 in Figure 59 (Audio 11) and mm. 278–307 in Figure 61 (Audio 12) bring these features to the fore in complementary

ways. The former illustrates that the principle of imitation need not connote contrapuntal “learnedness” so much as the playful pursuit of follow-the-leader. The latter, an elaboration of Gjerdingen’s *monte principale* schema, conflates a display of erudition with a childlike delight in *mimicry*.⁸⁸ Having previously appeared in the dominant as an element of the movement’s sonata-rondo design, Mozart’s *monte principale* returns to the scene of the crime, creeping back onstage with finger to lips: Mozart’s *pp* indication here signifies a Coreppellian “*piano, piano*” as much as an urbane *pianissimo*.

As Gjerdingen points out, a hidden beauty of the rising sequence produced by the *monte principale*’s repeated up-a-fourth, down-a-third motion can be drawn out by using it to generate canonic motion between two voices offset by a single note.⁸⁹ Taking advantage of this property, Mozart’s comic strategy is to overlay contrapuntal artifice on the most baldly homophonic textures of the entire sonata, not so much praising learnedness as burying it (a ceremonial act satirically set to the unremittingly homophonic strains of the “*Marche funebre del Signor Maestro Contrapunto*,” K. 453a [1784], which Mozart jotted down in Barbara Ployer’s *zibaldone*).⁹⁰ As did the descending broken chords in Figure 59 (mm. 17–22), the ascending scales that zigzag between the players at mm. 286–89 in Figure 61 adhere to protocol while mischievously hinting at what William Kinderman characterizes as the “careless abandon” with which the subsequent motive will be “tossed back and forth” (m. 293f), copycat-style.⁹¹ Predicated on the independence of voices (and hands) even as it compels each to march in mimetic lockstep with the others, the *ludus* of canon is strictly playful.

All this goes to show that imitative rigor can be as evocative—and invocative—of playful badinage as it is of ecclesiastical propriety or pantheistic sublimity. For Mozart, the rule-bound yet irreverent joy of such play was associated with a sacralized profanity most explicitly on show in scatological canons such as “*Leck mich im Arsch*” (K. 231/32c, 1782), a miniature six-part “box” designed using a similar schematic profile and contrapuntal mechanism to those from which the finale of the “Jupiter” Symphony was extrapolated and retrospectively laid out in thematic sequence.⁹² Another pair of such canons, written to be performed at the expense of Mozart’s Bavarian friend Johann Nepomuk Peyrerl, illustrate how both the observation and the breach of contrapuntal protocol can involve a streak of malice and one-upmanship that intensifies rather than dampens the prevailing ludic mood.⁹³ For Mozart, affection and mockery went hand in hand, as was vividly displayed by the caricatures he and his family commissioned as air-gun targets for the long-running series of *Bölzlschiessen* tournaments they hosted in Salzburg.⁹⁴ The pleasure taken by the Mozarts and their guests in taking aim at avatars of one another might be understood to index the popularity of digital games in general, and the first-person-shooter (FPS) genre in particular: both activities are agonistic tests of skill and nerve that take place in domestic settings, but encourage boisterous and ribald behavior.⁹⁵ It is in this sense that the Sonata for Two Keyboards unites its players in a shared endeavor while setting them at competitive odds. As a non-zero-sum game that is at once cooperative and potentially agonistic (at least for

those keeping score), it provides a convivial experience analogous to two-player arcade games in the tradition of Taito's *Bubble Bobble* (1986).⁹⁶

Ludomusically entrained players of K. 448/375a join forces to reel off skeins of luxuriant passagework in thirds and sixths, a facility that Clementi branded as a signature technique and displayed to impressive effect during the contest with Mozart. Yet if even Mozart felt at a disadvantage when enjoined to compete with such a “mechanicus,” so must his female students have thought twice before daring to joust with their teacher in public according to the professional code of conduct enumerated by his sonata's score.⁹⁷ In particular, Josepha Auernhammer's performance of gender led her to occupy an ambiguous position vis-à-vis Mozart: as a gifted keyboardist and composer who served as dedicatee as well as pupil and coperformer, she both fascinated and discomfited her teacher, who felt compelled to draw his father's attention to the sexual undercurrents that ebbed and flowed between them.⁹⁸ Beyond the overanalyzed confines of the Mozartian male psyche, such episodes testify to the erotic charge of two-player action at the keyboard and the threat it could pose to the maintenance of social order as well as to the exertion of control over selves and others.

4-3 CONCERTED ACTION

Before taking lessons with Mozart, Auernhammer had studied with the Dutch keyboardist Georg Friedrich Richter.⁹⁹ In Mozart's unvarnished opinion, Richter's playing was comparable with Clementi's: although technically secure, it was “coarse” and “belabored,” revealing an absence of the “taste and feeling” so evident in Strinasacchi's violin playing.¹⁰⁰ While Mozart looked more kindly on Auernhammer's qualities at the keyboard, he reported that she too “plucks everything apart” and “lacks that true, delicate touch, that singing quality in the Cantabile.”¹⁰¹ Mozart's unsparing criticism testifies to a competitive edge as well as the upholding of high standards, but it did not cool the personal warmth he felt for both. Richter was “the best fellow in the world—and not a bit conceited,” as borne out by the following exchange:

When I played for him, his eyes were totally fixed on my fingers—then he burst out: Good God!—how hard I have to work, until I sweat, and—still I get no applause—and you, my friend, your playing is so playful.—Yes, *I said*, but I too had to work hard so that I don't now have to work so hard *any more*.¹⁰²

Written the day before the concert he rustled up with Strinasacchi, Mozart's report to his father conveys Richter's sheer bafflement at the ludomusical brilliance on display. As Karl Barth put it, “Mozart plays and never stops playing,” and yet “behind his play there is an iron zeal.”¹⁰³ Mozart reaped the ludic fruits of his labor on multiple levels. In the background lay the countless hours of training from which his compositional, improvisatory, and performative skills had been honed (initially at Leopold's bidding). *Within the scope of a particular musical occasion, the joys of play*

emerged directly from a process of planning and design, whether it involved dashing off a scatological canon or scripting an entire concerto.¹⁰⁴ In the improvisatory moment, moreover, both forms of work were leveraged in the interest of play.

Much has been made of the etymology of “concerto,” in which the concepts of cooperation and rivalry contend with each other.¹⁰⁵ While both apply to Mozart’s concertos, his role was also akin to the *concertatore* of the *commedia dell’arte*, who served as “artistic planner.”¹⁰⁶ In lieu of formal rehearsals, the *concertatore* would “[go] over the plot outline with the cast . . . , [describe] any unusual behaviour that the characters are required to exhibit . . . , [give] directions for smooth entrances and exits, and generally [prescribe] the performance parameters within which individual improvisations are to be contained,” in Pietropaolo’s summary.¹⁰⁷ This well describes the roles that Mozart must have played not merely as composer and star performer, but as coordinator and director of a scratch ensemble for which sight-reading was the norm and rehearsal a rare luxury.¹⁰⁸ The performance of any given concerto was rare enough to qualify as a singular occasion, which surely played to Mozart’s strengths as musical event planner extraordinaire. Sensitive to matters of location, personnel, instrumental forces, and social register, Mozart tailored his musical materials to suit the circumstances as well as to outfit the performers to their best advantage.¹⁰⁹

In the case of the concertos that Ployer performed, evidence of such bespoke handicraft can be found in the adjustment of passagework to display her technical ability in a flattering light as well as in the way they measured up to the performance spaces afforded by her Viennese apartment (well suited to the scalable K. 449 in E flat) and her country house in Döbling (which could accommodate the larger forces and grander scope of K. 453 in G).¹¹⁰ Mozart took just as much care over concertos he was to perform himself, even if that entailed paying less attention to the legibility of the solo part and more to the calculation of the cumulative effect.¹¹¹ As Levin and John Irving observe, the keyboard part in the autograph of the Concerto in C minor, K. 491 (1786), is untidy to the point of occasional chaos: whereas Levin draws a parallel between the visual image of the score and the “disturbed . . . emotional content of the work itself,” Irving suggests that it was Mozart’s frantic haste in the face of a looming performance deadline that led him to litter it with erasures, reorderings, and variants, giving rise to ambiguous instances such as Figure 62.¹¹² At once archaic and *galant*, the *cadenza composta di salto* underpinning the soloist’s trill that signals the close of the exposition is clinched by a taut 4–3 suspension, pixelated by the Alberti figuration of the soloist’s left hand and haloed by the thrum of the accompanying violins (mm. 263–64). Immediately beforehand, however, the arcing flow of the right hand’s long-established stream of sixteenth notes suddenly dries up on the rocky outcrops of B flat₄ and E flat₆ as the horns blazon the climactic 6/4 triad (mm. 261–62).

Are Mozart’s dotted half notes shorthand or plaintext? Should players take Mozart’s unexpected measures at face value or treat them as an invitation to take their own? On the surface, this passage echoes numerous others from the solo



Figure 62. Mozart, autograph score of Keyboard Concerto in C minor, K. 491 (1786), i, mm. 257–65 (horn, solo, and cello/bass parts only). Reproduced from Robert D. Levin, ed., *Klavierkonzert c-Moll, KV 491: Autograph*, Royal College of Music, London (Kassel: Bärenreiter, 2014).

parts of Mozart's concertos that call for touching up with decorative filigree: the score is suggestively bare, offering a skeletal outline that invites the player to flesh out the musical surface in the manner commended to Miss Cecilia by Czerny.¹¹³ At such junctures, the strokes of Mozart's quill might be perceived as cautionary signs delimiting improvisation-shaped fissures for the performer to fill. For many, however, this apparent hole in the score's fabric (already marred by Mozart's messy rejiggering of the right hand's passagework in the previous four measures) calls less for spontaneous ingenuity than for discreet patchwork, the inconspicuous joining of Mozart's dots by a string of pitches that he would have deemed unobjectionable (if clearly not quite noteworthy). If successful, distinctive utterance is camouflaged as unmarked discourse by merging with its context.¹¹⁴

Insofar as the notes that Mozart wrote at this point stage an unexpected interruption of the undulating passagework, the literal route is in some ways the less foreseeable. Rather than opposing the spirit and letter of Mozart's notation, however, we might take account of both its mensural and its neumatic aspects by

treating the B flat₄ (which, as can be seen in Figure 62, survives only *sous rature*) not merely as a stand-in, but as a cadential springboard. From this perspective, the E flat₆ becomes a ceiling to be touched or even a bar to be cleared, while the preceding passagework forms the run-up to an acrobatic vault rather than a pattern to be dutifully extrapolated.¹¹⁵ The player is thus impelled to improvise, not so much in the sense of spontaneously producing a sequence of notes that conform to compositional protocol as in their presentation of an immediate and nonnegotiable challenge: get from *here* to *there* by any means necessary.

Both Levin and Irving observe that Mozart's score can be ultimately opaque in its refusal to yield (to) a "correct" reading, suggesting that we might understand its textual anomalies as indices of an ongoing process rather than as problems in need of definitive solutions.¹¹⁶ As it systematically unravels the irresolvability of certain ambiguities, Levin's detailed chronology of the layers in which Mozart's nib deposited the work's literal traces frames the writing of his score as a performance in its own right.¹¹⁷ The score stands as source code that makes legible the operations of selection, transformation, and recombination that brought it into being via paratactic cognitive processes carried out on paper (where they are indexed not only by notes, but also by erasures, cancellations, corrections, alternatives, and an extensive range of sigla). As Knepler noted, this type of code defies the "traditional musical terminology" of "variation" and "development" applied to ontologically stable "themes."¹¹⁸ The realization of Mozart's document at the keyboard involves (re)compilation rather than interpretation or mere execution, especially if we construe his compositional predicament regarding K. 491 to stem from his penchant for sailing close to the wind, putting himself in uncomfortable yet exciting proximity to the exigencies of improvisation *impromptu*.¹¹⁹

In this ludomusical light, the question of why Mozart's carefully contrived stepwise passagework should suddenly give way to a bounding leap might be met by his own parry of "warum nicht?"¹²⁰ Any given *grado* or *salto* may be staged in precise accordance with contrapuntal protocol, but the kinetic sequence of running and jumping in his concertos is more often a matter of navigating their challenging terrain with pyrotechnical aplomb.¹²¹ The topography of the keyboard constitutes a field of play that facilitates and constrains the hands' choreographed sequences of shapes and gestures as they run Mozart's gauntlet of ludomusical obstacles. In the case of Figure 62, it seems plausible that performing a show-stopping leap, physically and sonically arcing above the heroic arpeggiation of the horns, might be even more dramatic, more surprising, or simply more fun than continuing to hurtle up hill and down dale en route to the cadence.¹²²

In hailing the "compositional bravura" as well as the "combinatory agility and quick reflex" from which the "performative fireworks" of such quasi-improvisatory *Spielepisoden* are launched, Roman Ivanovitch deploys ludic terminology: Mozart shows off by virtue of "contrapuntal tricks" performed

Figure 63. Mozart, autograph score of Keyboard Concerto in F, K. 459 (1784), iii, mm. 1–5 (woodwind and solo parts only). Reproduced by permission of the Staatsbibliothek zu Berlin. CC BY-NC-SA 3.0 DE.

Audio 13. Mozart, Keyboard Concerto in F, K. 459, iii, mm. 1–33, performed by Malcolm Bilson, John Eliot Gardiner, and the English Baroque Soloists (Archiv 415 111–2).

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.20>



via “keyboard tactics” that might momentarily threaten to hijack formal strategy, but ultimately serve to expose the “rich playfulness of . . . Mozart’s virtuosic *Spielfreudigkeit*.”¹²³ Citing the passage culminating in Figure 62, Ivanovitch describes Mozart’s sonorous “dressing up” of simple alternations between tonic and dominant harmony in ways that capture “different poses or attitudes.”¹²⁴ Writ large, this elemental polarity between tonic and dominant is the source of the dialectical energy that animates Mozart’s concertos, from the syntax of their initial propositions and ripostes to their deepest formal articulations.¹²⁵ Open-ended and yet operationally closed, its *fort-da* allows Mozart to revel in the ludomusical pleasure of oscillation, which is particularly evident throughout the Arcadian adventures that the score of the Keyboard Concerto in F, K. 459 (1784), holds in store.¹²⁶

The sylvan romp of K. 459’s finale departs from the most understated of tonic-dominant alternations in the fortissimo, which, polyp-like, proceeds at once to divide and to multiply in the process of becoming a contredanse (Figure 63, Audio 13).¹²⁷ First the oscillation is revoiced and extended into what Gjerdingen dubs a “converging cadence”; then the four measures are reiterated, but with the twist of a *cadenza composta di salto* that flips the script, turning what was dominant into a momentary tonic of its own; and then, after all eight bars have been reprised by the raucous winds, the pattern of call and response is repeated (mm. 17–32),

restoring the tonic via a vertiginous series of diminished triads, each of which ambiguously hints at a dominant or diminished seventh.¹²⁸

Throughout the finale, the playful oscillation between tonic and dominant is matched by the ludic ambiguity of the opening rhythm, which insistently raises an analogous question: *an-a-pest* or *dak-ty-los*?¹²⁹ While metrical, harmonic, melodic, and gestural factors might mitigate on either side in any given instance, deciding on one way is less important than recognizing how easily it could go the other. Regardless of whether it was compositionally prescribed, the taking of such liberties was heard to suffuse the concerto's extemporized performance: Philipp Karl Hoffmann, who witnessed Mozart play K. 459 in Leipzig as part of the festivities celebrating the coronation of Leopold II in 1790, reported that he embellished the slow movement "tenderly and tastefully once one way, once another according to the momentary inspiration of his genius."¹³⁰

The passage leading up to the first movement's cadenza (Figure 64, Audio 14) reprises in the tonic a sequence of themes that had itself first appeared in the dominant (m. 203f.). This music departs from the previous script by landing on a dominant pedal (m. 430), over which anticipation rises via an ascending chain of 7–6 suspensions, busily embroidered by the fortepiano's sixteenth notes and punctuated by perky anapestic exchanges that ping-pong across the wind section. At m. 441, the attainment of the tonic marks not so much an arrival as a redoubling of the pace of harmonic and rhythmic change: orchestral dialogue becomes breathless hocket as the keyboardist breaks out into a double-handed descending series of broken chords that outline a Romanescan alternation of 5/3 and 6/3 sonorities, subsequently echoed by the orchestra (m. 447f.) as a more rustic sequence of root-position triads homing in on the 6/4 chord—a momentary amalgam of tonic and dominant functions—that will serve as the cadenza's launch pad.¹³¹

The movement ends by way of a process of multiplication through division that mirrors its opening gambit: quick-fine dominant-tonic cadences are repeatedly flung across the ensemble via what Janet M. Levy described as a spate of "copycat mimicry" that "brainlessly and playfully" brings proceedings to a frantic close.¹³² To reflect and enact the "short-winded, back-and-forth chatter" of these closing measures, Levy provided (and even performed) a paratext somewhat akin to that which Mozart wrote for Leutgeb in the autograph of the Horn Concerto in D: "Will you, won't you, will you, won't you, will you' . . . close this piece?"¹³³ As Levy's antics indicate, the nested series of playful calls and responses that animate the movement as a whole evoke the "classical" virtues of symmetry, balance, reiteration, and formal dialogue less vividly than the scalable and reiterable logic of a children's game.

In her book *The Games Black Girls Play*, Kyra D. Gaunt addresses the music and movement that emerge from the playground via ludic activities such as skipping, improvised rhyming, and double-dutch, describing "game-songs [as] embodied scripts of music, inscribed into space, experience, and memory."¹³⁴ Adopting such a ludic

This is a handwritten musical score on aged, yellowed paper. The score is written on ten staves. The notation includes various rhythmic values and melodic lines. Arabic text is written below the staves, with some words appearing in boxes. The text includes:

- At the top of the first staff: **م**
- Between the first and second staves: **م**
- Between the second and third staves: **م**
- Between the third and fourth staves: **م**
- Between the fourth and fifth staves: **م**
- Between the fifth and sixth staves: **م**
- Between the sixth and seventh staves: **م**
- Between the seventh and eighth staves: **م**
- Between the eighth and ninth staves: **م**
- Between the ninth and tenth staves: **م**

Dynamic markings are present in several places:

- Between the fourth and fifth staves: **Mätschibi - nitschibi**
- Between the sixth and seventh staves: **Mätschibi - nitschibi**
- Between the seventh and eighth staves: **Dinaminimi...**
- Between the eighth and ninth staves: **Dinaminimi**
- Between the ninth and tenth staves: **Dinaminimi**

The page number **395** is written at the bottom center.

This page contains a handwritten musical score on ten staves. The notation is dense and includes various symbols, including what appears to be a form of shorthand or a specific musical notation system. The score is annotated with several labels in small boxes:

- Staff 1: Three boxes labeled "Punktschritt" are placed above the notation.
- Staff 2: A box labeled "Punktschritt" is placed above the notation.
- Staff 3: A box labeled "Punktschritt" is placed above the notation.
- Staff 4: A box labeled "Nätschibi - mitschibi" is placed above the notation.
- Staff 5: A box labeled "Nätschibi - mitschibi" is placed above the notation.
- Staff 6: A box labeled "Nätschibi - mitschibi" is placed above the notation.
- Staff 7: A box labeled "Drittmenschen" is placed above the notation.
- Staff 8: A box labeled "Punktschritt" is placed above the notation.
- Staff 9: A box labeled "Punktschritt" is placed above the notation.
- Staff 10: A box labeled "Punktschritt" is placed above the notation.

The notation itself consists of vertical lines on the staves, with various symbols and characters interspersed. Some symbols resemble musical notes or rests, while others are more abstract. The handwriting is in black ink on aged, slightly yellowed paper.

This image shows a page of handwritten musical notation on ten staves. The notation is a form of shorthand, possibly a shorthand for a specific musical style or a personal shorthand. The notation includes various symbols, lines, and markings. A central label reads:

Nüttschi - bi - Nüttschi - bi - Nüttschi - bi - Nüttschi - bi - Nüttschi - bi

The notation is organized into several groups, with some groups appearing to be repeated or modified. The handwriting is fluid and characteristic of a personal shorthand system.

approach promises to illuminate the processes by which Mozart's finale emerges, is remembered, and is recreated via the performance of *mimicry*. In the insouciant spirit identified by Levy and Gaunt, we might seek to convey the irresistible ludomusicality of the thematic, harmonic, and rhythmic oscillations that propel Figure 64 by resorting to Mozart's glossolalic predilection for setting nonlexical vocables to music, traceable to a childhood bedtime ritual at which he sang the cod-Italian "Oragna fiagata fa marina gamina fa" to the storied Dutch melody of "Wilhelmus van Nassouwe."¹³⁵ The habit never left him: traversing the polyglot territory between Vienna and Prague in 1787, Mozart and his companions devised rhyming nicknames for one another. The organist Franz Jakob Freystädler became known as Gaulimauli, the clarinetist Anton Paul Stadler as Nätshibinitschibi, the violinist Kaspar Ramlo as Schurimuri, Elisabeth Barbara Quallenberg as Runzifunzi, and Mozart himself as Pünkittititi; his servant Joseph was dubbed Sagadaratà, while his keyboard pupil Franziska von Jacquin rejoiced in the name of Signora Dinimininimi.¹³⁶ Later that year, Mozart musically deployed "Gaulimauli" as the canonic payoff of a Hanswurstian prank played on the unfortunate Freystädler ("Lieber Freystädler, lieber Gaulimauli," K. 232/509a).¹³⁷

By catachrestically following Mozart's lead and distributing Gaulimauli's fellow sobriquets across Figure 64, I claim no insight into the "deeper meaning of the names of this brother- and sisterhood," as Einstein described it, but aim instead to imagine the sonorous conditions under which such meaning(lessness) could conceivably have emerged.¹³⁸ The rhythmic profiles and phonemic articulations of vocables such as "Pünkittititi," "Nätshibinitschibi," "Dinimininimi," and "Sagadaratà" stand as culturally plausible means by which this music might have been imagined, embodied, entrained, remembered, performed, and represented without being yoked to conceptual or interpretive models predicated on semantic meaning. As Novalis put it, "babbling . . . is the infinitely serious side of language" precisely insofar as its "play is self-sufficient" and yet precisely mirrors "the strange play of relationships among things" through "its tempo, its finishing, its musical spirit."¹³⁹ From this perspective, perhaps the most musically suggestive nickname is that bestowed on the addressee of Mozart's letter from Prague, Gottfried von Jacquin, whose hemiolic moniker of HinkityHonky maps neatly onto the three-against-two played out between the soloist's hands in the wake of the cadenza (m. 454f.).¹⁴⁰

Although they filtered from Mozart's pen, these nonsensical names did not issue from his mind alone, but rather from the high-spirited interplay among all the occupants of the carriage traveling from Vienna to Prague—and perhaps even from their impressions of the unfamiliar languages and dialects to which they were exposed en route. Analogously, Mozart's virtuosic choreography of the rhythmic, melodic, harmonic, and contrapuntal schemata that compose the finale of K. 459 relies on the actions of others as both stimulants and respondents. Alongside the chattering strings and loquacious fortepiano, the brashness of the winds completes a triangulation that pushes at the limits of dialogical approaches to the movement. As Karol Berger remarks, the "rule-governed improvisation" of the *commedia*

dell'arte provides a more compelling model for the staging of encounters among such a cast of characters, played by or as Mozart and Company.¹⁴¹ The *grammelot* of their real-life stage names testifies to the subjunctive logic of *mimicry*, the actuality of its make-believe, the logic of its nonsense, the bottom line of its invertibility—and vice versa.¹⁴² Is the game real, or reality a game? Is the stage a world, or the world a stage? As with tonic and dominant, dactyl and anapest, the answer lies not in between, but in the processes of turning and shuttling from one to the other.¹⁴³

Germaine de Staël invoked the playing of instrumental music in her characterization of the “well-being [engendered by] a lively conversation,” contending that “the principal interest does not lie in the ideas and knowledge that can be developed; it is a certain manner of interacting with others, of giving reciprocal pleasure.”¹⁴⁴ Bypassing the representational dilemma of whether *this* stands for *that*, Mozart’s ludomusical processes circumvent the allegorical imperative to assign deeper meaning to one term or another in line with nomenclatural conventions, social mores, or hermeneutical hierarchies. *Lusus enim suum habet ambitum*: observing, breaching, and drafting rules need not be synonymous with innocence, guilt, and the passing of judgment. Accordingly, the theatrical mechanics and dynamics of play cannot be explained (away) solely by attributing significance to the adherence to or deviation from formal principles, semiotic procedures, or narrative expectations. Whether imposed from outside or within, such boundaries have ludomusical properties and functions that supplement—and even defy—the constraints they nominally enforce.¹⁴⁵

As a genre, the concerto has been dogged by the discrepancy between its popularity as a quasi-gladiatorial musical event to be relished in the flesh and its cooler reception in print: the live(li)ness of its play is attenuated when recollected in tranquility. From Sulzer to Allanbrook and Koch to Currie, critics have taken widely divergent positions on the ethos of the concerto, its construction of agency and identity, its dramatic and poetic qualities, its relation of the individual to society, and its broader political implications.¹⁴⁶ Most, however, agree on the broad definition of its dramatic parameters, which are heard—or, more commonly, read—to articulate contrast and difference, whether between soloist and orchestra, style and content, virtuosity and substance, or competition and cooperation.¹⁴⁷ Positively or negatively, the dialectical implications of such distinctions are typically redeemed in the moral currency of edification or the admission of guilty pleasure, both of which can be understood to respond to the concerto’s suspect character, its licentious weakness for the kitschy, the trivial, and the meretricious.¹⁴⁸

On these grounds, Levy’s insistence on the “brainless playfulness” of K. 459’s finale has been ambushed by a pincer movement from Allanbrook and Currie (unlikely though the alliance might seem). Whereas Allanbrook struck an uncharacteristically censorious tone in claiming that the ending “crowns the long-term development of an important rhythmic motto” and is thus “syntactically and affectively indispensable,” Currie draws an agonistic distinction between

the movement's free and easy *buff* idiom and the "authoritarian world of learned style" with which he identifies the theme that enters on the heels of the opening rounds of call and response (m. 32f., reprised at m. 416f in Figure 64).¹⁴⁹ Currie's sharply delineated political reading thus relies on a dichotomous interpretation of musical features that, to my ear, are hopelessly and infectiously compromised from the start (at least in performances even minimally attuned to eighteenth-century sensibilities). On the theme's initial appearance, its imitative properties are typical of what Allanbrook nicknamed the "lickety-split learned style," the polyp-like outgrowths of which are less symbolic of ecclesiastical rigor than they are demonstrative of the welter of comic invention on display.¹⁵⁰ The assiduously archaic working out of the theme's polyphonic potential in the movement's central double *fugato* constitutes a pedantic exception to the prevailing ethos even as it asserts the rule of contrapuntal law. As a result, the D-minor shadow it casts is that of a pantomime villain such as Mozart's *dottore* (see Figure 44), whose pretensions are travestied by the brilliant figuration in which the theme is clothed at the keyboard (as in m. 416f in Figure 64). Mozart's canons gleefully demonstrate that learnedness can be a vehicle for (as well as the target of) grotesque, absurd, and scatological irony; at the same time, they reveal how the entraining force of comedy can itself convey elements of malice, coercion, and even tyranny.¹⁵¹

Seeking to move beyond dialogical and rhetorical models, Edward Klorman posits a theory of multiple agency to take account of the "diverting forms of social intercourse" played out by the performance of chamber music.¹⁵² Similarly, and with specific regard to Mozart's keyboard concertos, Timothy Jones notes the "untidiness of the clamour of multiple agents and their dynamic relations," which strike a "precarious balance" between the "containing forces of formality and decorum" and the "anarchic threat of heteroglossia."¹⁵³ Testifying to the delightfully dizzying capacity of *ilinx* to "inflit a kind of voluptuous panic" on the regulative operations of rationality, the pantomimetic virtuosity exhibited by this music reflects and gives rise to the riotous yet harmonious (mis)adventures of a Harlequinesque figure, his allies, and his foes as they unfold against a carnivalesque backdrop.¹⁵⁴ In this regard, Mozart's scores can also be seen and heard to anticipate the antics of another digitally rendered Italianate avatar, who would take to the electronic stage two centuries later.

4-4 MOZART AND MARIO PLAY THE FIELD

Regardless of their stylistic and terminological orientation, readings of Mozart's music often run into a stumbling block in the form of the atemporal fixity that they both discover and manifest. The most imaginative attempt to overcome this limitation in the interest of registering the playfulness of Mozart's music has been undertaken by Pesic, who provides entertaining commentary on the "game plan"

of the finale of the Keyboard Sonata in B flat, K. 570 (1789).¹⁵ In finding musical analogs for the *jeux innocents* of chasing, catching, hiding-and-seeking, racing, dueling, leapfrogging, daring, guessing, and pretending, Pestic draws attention both to the intensity of the experience that Mozart's score represents and to the ludic qualities that emerge from reading it to articulate the rules of a musical game.¹⁶ Yet even this compelling strategy ultimately offers an ex post facto rationalization of music's playful phenomenality, a written account beholden to the authority of the score as determined by Major League Mozart. The same applies to the realms of performance and recording: insofar as it involves the dutiful declamation of a well-known text, a contemporary rendition of K. 459 stands at a far remove, aesthetically as well as historically, from the live-wire contingency of the concerto's emergence as ludomusical event.

Iconic signs of play are occasionally to be found in the scores of Mozart's concertos. A folio in the autograph of K. 449 features a mysterious array of marginalia consisting of geometrical symbols, numbers, and doodles (Figure 65) that seem to have been ludically motivated, whether as stimulation or distraction. In the case of K. 491, as we have seen, Mozart's extensive process of revising and reordering necessitated the deployment of an unusually wide range of sigla: having exhausted his customary lexicon of circles and crosses, he resorted to cartoon-like depictions of human hands (Figure 66) and faces (Figure 67). The former iconically perform the indexical function of pointing to the location at which material is to be inserted, while the latter retrospectively look in its direction.

Beyond the whimsy of these iconographical correlations, the sweeping strokes of Mozart's pen do more than convey, delimit, and distinguish between different types of musical information. To the extent that they stand as traces of physical gestures, their neumatic qualities testify to the physical forces of inertia and gravity, leaps and arabesques, slides and bumps, ricochets and recoveries. As suggested above in relation to K. 491 (Figure 62), these attributes come to the fore when, rather than reading Mozart's scores exclusively for the musical contents they distribute across an abstract two-dimensional plane, we approach them as ludomusical landscapes that map terrain to be (more or less) dexterously navigated by the hands of players and registered via their facial expressions. The barbed annotations aimed at Leutgeb reveal Mozart's awareness—and manipulation—of the expectation that a similar principle applies in reverse to the neumatic gestures by which such scores are instrumentally realized via embodied acts.¹⁷ At the fortepiano, as Pestic points out, players' actions at once defy and accede to the prevailing physical constraints: "despite the apparent uniformity of the keyboard, not every direction is the same. . . . Ascents are dizzying and falls vertiginous, but in an ideal realm without the possibility of harm."¹⁸ Play affords the excitement of testing physical limits over the subjunctive safety net that ensures its consequences will not be fatal, even for the hapless Leutgeb.¹⁹

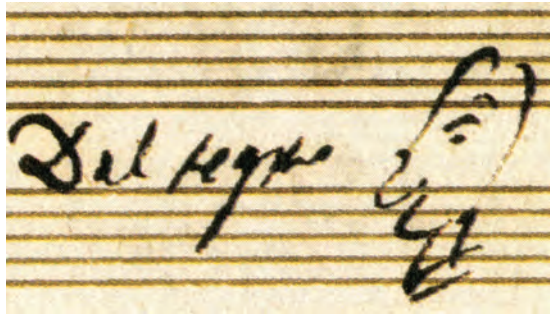
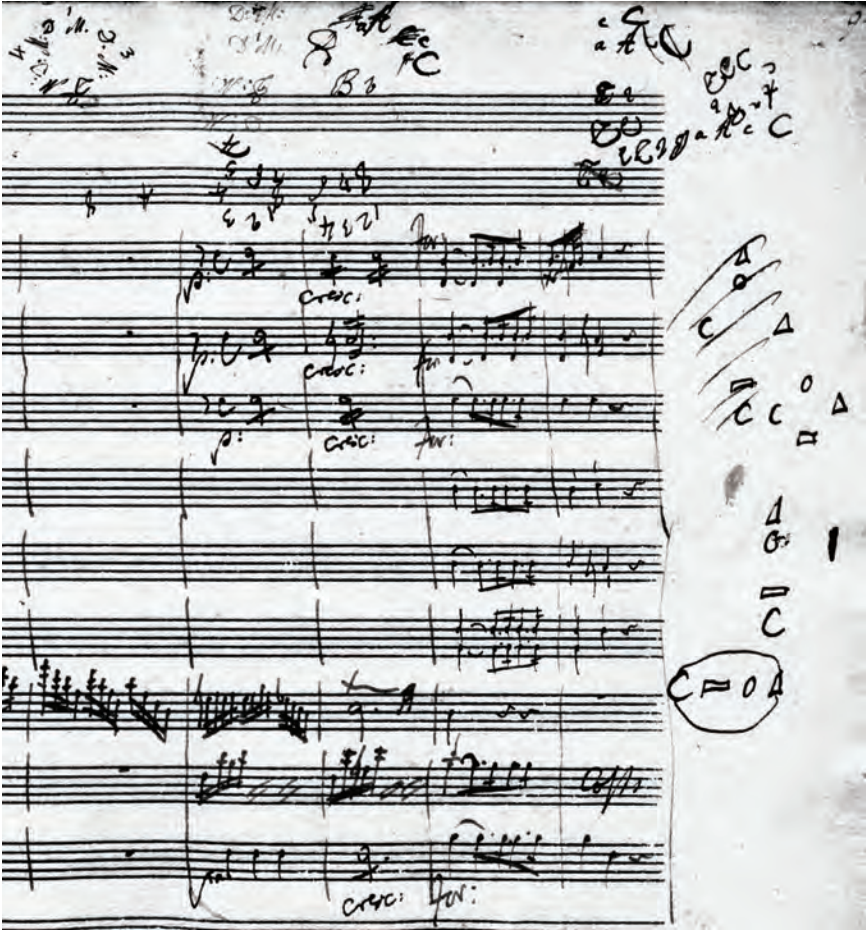


Figure 65. Mozart, autograph score of Keyboard Concerto in E flat, K. 449, folio 9r., i. mm. 166–70. Reproduced by permission of the Biblioteka Jagiellońska, Kraków.

Figures 66 & 67. Mozart, sigla in autograph score of Keyboard Concerto in C minor, i. mm. 90 and 491.



Figure 68. Mozart, autograph score of Keyboard Concerto in F, K. 459, ii, mm. 43–52. Reproduced by permission of the Staatsbibliothek zu Berlin. CC BY-NC-SA 3.0 DE.

Audio 15. Mozart, Keyboard Concerto in F, K. 459, ii, mm. 43–52, performed by Andreas Staier and Concerto Köln (Teldec 8573–80676–2).

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/huminos.16.22>



The promise—if not quite the guarantee—that barbs will not pierce, that muck will wash off, and that, if all else fails, one can always play again is particularly characteristic of K. 459’s urbane pastorality, different dimensions of which are on display in all three movements. The artful artlessness of the central Allegretto evokes Marie Antoinette’s Hameau de la Reine, the notorious rustic retreat built at Versailles in 1783 for the queen and her closest friends to play at being shepherdesses and milkmaids. At once a real farm and a simulation of one, the Hameau framed laborious tasks as ludic (re)enactments to be performed with studied naïveté. In Mozart’s Allegretto, the flute’s riff on the opening material flutters into a rustic tune over the cushioned tonic-dominant undulations of the strings (m. 44f., Figure 68 and Audio 15). After the fashion of Mozart’s comic rounds, the bassoon’s ingenuous echo stumbles upon the melody’s serendipitous suitability for imitation, which the fortepiano notes via the strict *mimicry* of follow-the-leader (mm. 48–51).

As Andreas Staier observes, this music “almost starts to link arms and sway from side to side,” but the blissful entwining of limbs engenders unexpected



Figure 69. Map of final area from World 1-1 of *Super Mario Bros.* (Nintendo, 1985). Image reproduced courtesy of Ian Albert.

contrapuntal ramifications.¹⁶⁰ Shepherded by the soloist's right hand, the bassoon reprises its trick on the theme's return in the tonic (m. 103f). This time, having learned its contrapuntal lesson, the keyboardist's left hand tacitly cues the oboe to enter at the theme's third measure before bringing up the rear one measure later, laying bare the full extent of the theme's fourfold canonic potential.¹⁶¹ The self-evidence of this complexification suggests how processes of variation, elaboration, departure, and return might be understood not merely in abstract formal or relational terms, but as iterative elements of ludomusical design. Such elements shape the embodied experiences of players by staging the acquisition of knowledge and skill via the navigation of obstacles and the solving of puzzles that become progressively more demanding—and thereby revealing.

Super Mario Bros., conceived for the Famicom (known outside Japan as the Nintendo Entertainment System) by Shigeru Miyamoto and Takashi Tezuka in 1985, stands as a locus classicus of such design.¹⁶² As Mario moves from left to right against the pastoral backdrop of the opening course, the latter stages of which are illustrated in Figure 69, he encounters an assortment of blocks, pipes, and shiitake-like Goombas that pose various types of challenges. Negotiating the first stepwise set of symmetrically ascending and descending blocks requires Mario to learn how to leap between them; in the case of the second set of blocks, a broader takeoff area only slightly mitigates the cruel fact that if Mario fails to clear the gap, he will plummet into an abyss. If he succeeds, however, he will be rewarded with the opportunity to climb a far more imposing staircase of blocks, which will in turn afford the chance not only of completing the course by taking down his archrival Bowser's flag, but of showing off (and gaining extra points) by shimmying down the entire height of the flagpole.

*Like a Mario game, the playing of a Mozart concerto primarily involves interactive digital input: in prompting both linear and looping motions through time and space, it responds to imaginative engagement rather than hermeneutical exegesis.*¹⁶³ While "Mozart" and Mario star as protagonists, they share the stage with other characters who act as allies, cheerleaders, foils, and foes.¹⁶⁴ Beyond the specific functions of individuals, the ensemble puts forth its concerted efforts in the interests of communal pleasure, whether it take the form of raw exhilaration, sentimental delectation, or—perhaps most tellingly—the *lieto fine* of hard-won

triumph over the frustrations posed by obstacles, blockers, and platforms that are liable to tilt.¹⁶⁵

This catalog of elements implies that certain attributes held in common by Mozart and Mario can be triangulated by reference to the ludic system of the *com-media dell'arte*, in which light it is revealing that Miyamoto has characterized Mario and his fellow cast members as “one big family, or maybe a troupe of actors.”¹⁶⁶ As a manual laborer, physically resourceful yet capable of speaking only in cod-Italian *grammelot* and besotted with a woman out of his league, Mario is closely related to Harlequin: while the outlines of the plot and the rules governing the operation of the game are prescribed, unforeseen complexities inevitably emerge when either figure enters the field of play.

As the ever-changing score reflects, no two games are alike, and a qualitative reckoning of the ludic experience does not necessarily correspond with the quantitative ranking of one above the other. The uncertainty, surprise, laughter, profit, and even enlightenment that can emerge from what might appear to be a frivolous diversion are indicative of a ludomusical system designed not only with great care and precision, but also with attentiveness to the diverse needs, desires, and qualifications of its users. Though the playing as well as the writing of his concertos, Mozart created roles with which a wide range of performers and listeners could readily identify. In this regard, his most famous remark concerning his concertos can be set alongside a statement by Miyamoto, Mario’s celebrated designer, concerning *New Super Mario Bros. Wii* (2009):

These concertos [K. 413–15] are a happy medium between what’s too difficult and too easy—they are Brilliant—pleasing to the ear—Natural without becoming vacuous;—there are passages here and there that only connoisseurs can fully appreciate—yet the common listener will find them satisfying as well, although without knowing why.¹⁶⁷

I hope that a wide range of users will be able to enjoy [*New Super Mario Bros. Wii*] in a wide variety of different ways. . . . We’ve come up with a title that everyone, from those who are relatively unskilled right through to those who are highly skilled, can all enjoy.¹⁶⁸

Players, spectators, and listeners of all stripes have been entrained by the dexterous traversal of the ludomusical landscapes designed by Mozart and Miyamoto for the playing of their *jeux innocents*. Relying on a variety of props as both aids and hazards, both blocked out sequences that made stringent yet negotiable demands of performers while affording them ample opportunity to display their virtuosity and ingenuity.¹⁶⁹

The affinities between the composition of a Mozart keyboard concerto, the design of a digital game, and the playing of both are easier to perceive when Mozart’s scores are apprehended in the terms of “new” as well as “old” media.¹⁷⁰ To explore the resonances between “Mozart” and Mario as digital avatars, we must take a second ludomusical pass at the helter-skelter passage from the finale of K. 459



Figure 70. Screenshot from *New Super Mario Bros. Wii* (Nintendo, 2009), World 9–7.

Video 8. “Super Skills” gameplay video from *New Super Mario Bros. Wii*, World 9–7, set to recording of Mozart, Keyboard Concerto in F, K. 459, iii, mm. 391–453, by Andreas Staier and Concerto Köln (Teldec 8573–80676–2).

To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/huminos.16.23>



notated in Figure 64. This time, instead of stewing the music with the echolalia of eighteenth-century nicknames, I have set Staier and Concerto Köln’s recording of the passage (Audio 14) as a soundtrack to the “super-skilled” playing of an advanced course (World 9–7) from *New Super Mario Bros. Wii* (Figure 70 and Video 8). As with Mozart’s initial presentations of his own keyboard concertos, such adroit and imaginative performances issued from the digits of those responsible for the game’s creation and were put on display to delight and impress a broad range of players, regardless of their capacity to emulate them (or even to appreciate their subtleties).

Insofar as the staging of this encounter between “Mozart” and Mario seeks to realize types of ludomusical motion implied by the concerto’s notation, it echoes Malinowski’s melographic animation of the Sonata for Two Keyboards (Figure 60), further repercussions of which will be traced in Key 5–4. Placing these unlikely interlocutors in audiovisual dialogue here does not posit one-to-one correspondences between their motives, actions, and effects, but rather activates a ludomusical counterpoint from which suggestive sonorities might emerge. Unlike Kōji Kondō’s celebrated soundtracks, Mozart’s music was hardly written to Mario’s order, just as Mario’s movements were not choreographed to Mozart’s score; as a result, even the most salient points of comparison are profoundly asynchronous.¹⁷ That notwithstanding, Mario’s initial gaining of momentum is matched by “Mozart”’s teetering from triplets to sixteenth notes in mm. 403–4, from which point both

embark on a series of gratuitous yet perfectly calibrated vaults, pirouettes, and somersaults. At the appearance of the “lickety-split learned” theme, Mario powers up into Fire Mario: the ensuing pyrotechnics spread a whiff of gunpowder over the Arcadian scene. The excitement built over the dominant pedal at m. 430f. finds a visual analog in the lengthy horizontal platform of ice blocks upon which Mario slides, under which he ducks, and over which he leaps, outwitting enemies and filling his pockets to the acclaim of the diegetic audience. Finally, the hurly-burly of the twofold Romanescan burrowing toward the 6/4 chord that will trigger the cadenza is matched and inverted by Mario’s gratuitously acrobatic leap to the apex of the pole that marks the course’s conclusion, flagging up the triumphant completion of this leg of his quest and impelling him to break the fourth wall in acknowledgment of the audience (which, in the case of K. 459, is primed to acclaim the successful navigation of the ensuing cadenza and postlude).¹⁷²

From this perspective, Mozart’s keyboard concerto is not a work, a text, or even a script, but a game: its score is a rulebook that encodes, facilitates, and regulates the behavior of its players. In the neoclassical light of *New Super Mario Bros. Wii*, we might say that Mozart designed the finale of K. 459 not merely as a *canovaccio*, but as a first-person adventure to be witnessed from a third-person perspective. He mapped out runs and leaps fit for a daredevil; he provided players with the means and incentives to display their most refined combinations in the face of risk and reward; and he sketched the algorithmic outlines of Harlequinesque interactions with the nonplayer characters (NPCs) of the orchestra. With the reverse skeuomorph of Mozart’s concerto in our fingers and ears, conversely, we might discover ways of feeling and hearing Mario’s graceful play with fire and ice to be imbued with an extra layer of affective nuance, its irrepressible kineticism in thrall neither to the mensural grid of bar lines nor to the pedantic precision of the CPU’s clock.¹⁷³ By way of the ludomusical sensibilities of Mozart and Mario, the rhythmical mechanics by which notes can be organized and gameplay systematized are rendered both tangible and abstract. Mediated via digital interfaces, playful experiences thus become available for mental processing, embodied performance, and social circulation.

4-5 BEETHOVEN’S RECURSIVE FEEDBACK LOOPS

As the most celebrated documents of their kind, Beethoven’s Fifth Symphony, op. 67 (1804–08), and the laudatory review by Hoffmann that subsequently appeared in the *Allgemeine musikalische Zeitung* stand in synecdochic relation to the nineteenth-century canonization of “classical” music and to the interpretive mode that proceeded to define music criticism, each of which sustained the other.¹⁷⁴ Hoffmann hailed the symphony’s thematic economy as a demonstration of organic unity rather than of associative, aggregative, and combinatorial ingenuity, and thus the outcome of intelligent design rather than autopoietic play: the “absolute authority” of Beethoven’s “rational genius” had left nothing to chance.¹⁷⁵ At the

same time, Hoffmann set out to convey how the elevated and immersive register of Beethoven's music could transport listeners far from their mundane surroundings.

This presented a challenge: How could the ennobling and transfigurative qualities of aesthetic immediacy be captured and transmitted to readers via the cold medium of print? On the one hand, they were invoked and imagined via Hoffmann's perusal of musical notes, the most significant (which is to say the least redundant) of which were excerpted and transcribed for subscribers to apprehend at their own keyboards. On the other, the meanings of such notes were transcoded into letters via an elaborate hermeneutical process that Hoffmann teased out and modeled for his readers, making the case that great music must be (re)viewed, not merely heard, in order to assume its rightful standing in the artistic pantheon.

As Hoffmann was all too aware, irony glared from the fact that music's coronation as "the most Romantic of all arts" had to be articulated and performed by words, and in particular by his distinctive suturing of poetic and technical discourses.¹⁷⁶ Both despite and by way of Hoffmann's rapturous paeans to sound's enchanting powers, his multifarious writings demonstrated how the creation and perception of Romantic music could be represented—and even made conceivable—by literary media and processes of writing, whether figured as inscription, prescription, or transcription.¹⁷⁷ The imbrication of the rhapsodic and the analytical, the natural and the artificial, played an important role in establishing the channels through which instrumental works could be simultaneously approached as portals to other realms and reified as quasi-scriptural textual artifacts.¹⁷⁸ Both functions depend upon reiterability, which enables a work to serve both as the grounds for performance of a ritual (in which Platonic capacity it is at once repeatable and variable) and as an object of analysis (in which form it remains obstinately stable, just as Socrates had complained).¹⁷⁹ An article attributed to Giuseppe Maria Cambini that appeared in the *Allgemeine musikalische Zeitung* six years before Hoffmann's review of Beethoven's Fifth illustrates the antiludic implications of such reiterability in the context of Haydn's string quartets, the performance of which should be tackled as serious work rather than commediated play.¹⁸⁰ The author exhorted instrumentalists to "repeat often the foremost works in this genre, thus learning all of the nuances of the intended execution. . . . [Even] the best actor would not dare to give a scene from a distinguished play without having often gone through it. It causes me grief, and I must shrug my shoulders helplessly, when I hear musicians say: 'Come, let's play quartets!' just as lightly as one says in society, 'Come, let's play a game of Reversis!'"¹⁸¹

Across literary as well as musical and theatrical realms, as Esterhammer has shown, written texts began to constitute "the norm against which all . . . production must be measured."¹⁸² In Samuel Taylor Coleridge's terms, a poem becomes "essential" by dint of its capacity to be observed in light of previous observations; conversely, its un(re)readable counterparts fade into obscurity, however much

fl eeting pleasure they might have given.¹⁸³ By this criterion, the power of a piece of music lies in its ability to draw both players and listeners back repeatedly, a feat it can only perform if it is understood to exist primarily as text rather than utterance, pattern rather than instance, a phenomenon to be beheld rather than enacted. Hewing closely to Aristotelian principles, Coleridge rejected the idea that unforeseen events could shape poetic form and matter, declaring his “full faith” in the notion that “poetry . . . is essentially *ideal*, avoid[ing] and exclud[ing] all *accident*.”¹⁸⁴ In a similar spirit, the staunch classicist Pietro Giordani decried poetic improvisation as “nothing but LUDUS IMPUDENTIAE.”¹⁸⁵

Despite the rhetorical downplaying of improvisation, however, the phenomenon of extemporaneity was scarcely eliminated: instead, it was reassigned to the performance and representation of inscriptive and interpretive acts themselves. Coleridge, who was fond of delivering off-the-cuff public lectures, even “extemporized” an introduction, dialogue, and poem called “The Improvisatore” (1828), which he claimed to have spontaneously written and dispatched to the publisher, the ink still wet.¹⁸⁶ Similarly, the masked imbroglio of Hoffmann’s novelistic “capriccio” *Prinzessin Brambilla* (1820), set during the Roman carnival season, thematizes the improvisatory *Spieltrieb* of the *commedia dell’arte* while promoting it not only as a principle governing the text’s own generation, but also as a strategy to be adopted by the conspiratorial reader.¹⁸⁷

The ontological and medial assumptions on which Coleridge and Hoffmann predicated artistic significance held negative implications for the type of encounters scored and staged by Mozart, which, as we have seen, were often tailored to the demands of specific figures and occasions. In stark contrast to such attentiveness to worldly exigencies, Hoffmann’s *Kapellmeister* Kreisler describes the act of composition as an unforeseeable and quasi-unconscious process: it involves the transcription of rarefied sounds audible only to those chosen few blessed with the preternaturally acute sense of hearing that bespeaks the soul of an artist.¹⁸⁸ The generation of unforeshadowed material, whether cast in the terms of originality or novelty, could no longer be outsourced to the paper machinery of *Würfelspiele* or even to their more respectable pedagogical counterparts. Instead, paper served as a storage medium for the symbolic output of sonic signals recursively turned inward to be processed by mind and body, a symbiosis most recognizably personified by the figure of Beethoven wandering through the woods with sketchbook in hand, at once conducting his fieldwork and illegibly transcribing the quasi-oscillographic contours of its data as heard and imagined.

Under these conditions, improvisation was caught in a double bind owing to the ever-greater authority ascribed to the written note. A watershed is famously marked by the score of Beethoven’s “Emperor” Concerto, op. 73 (1809–11) in which he deemed it necessary to forbid the performer—whose identity was now formally severed from that of the composer—from improvising: “Non si fa una cadenza, ma

s'attacca subito il seguente."¹⁸⁹ The written cadenza simultaneously indexes improvisation and expunges it, literally scoring it out. This narrowing of improvisatory scope is in line with the Romantic fixation on particularity and autonomy that disavowed the comic fungibility of play, with the rise of Goehr's work concept, and with the mediological onset of Kittler's "discourse network 1800."¹⁹⁰ It also happens to map neatly onto biographical narratives involving the deterioration of Beethoven's hearing, the transition from his "early" to his "middle" period, and his concomitant withdrawal from Mozartian sociality into Kreislerian solitude.

Yet the fact that the score of the "Emperor" Concerto is peppered with figured-bass numerals indicates not only that the wholesale identification of Beethoven's music with these tendencies is historically suspect, but also that the criteria used to distinguish between prescriptive, descriptive, and suggestive textual elements are themselves historically mediated.¹⁹¹ Within Beethoven's oeuvre, the hermetic qualities of op. 73's cadenza form a striking contrast to the Mozartian insouciance with which Beethoven had approached the Concerto in C minor, op. 37 (1802–03): according to Ignaz von Seyfried, he performed the solo part from "a few unintelligible Egyptian hieroglyphics" scattered over otherwise empty staves, and when Ferdinand Ries dared to ask for a cadenza, Beethoven refused, telling him to come up with his own.¹⁹²

This suggests a degree of continuity with the ludomusical patterns established by Mozart's appearances as composer-performer on the Viennese scene, intensified by specific resonances between op. 37 and K. 491 and even agonistically staged by the cadenzas that Beethoven supplied for Mozart's Keyboard Concerto in D minor, K. 466.¹⁹³ At the same time, it implies that the attenuation of Beethoven's public profile as an improviser at the keyboard in the first decade of the nineteenth century was coeval with a relocation of the act of realization from the making audible of sketched "Egyptian hieroglyphics" in op. 37 to their literary transformation into the *Fassung letzter Hand* of the "Emperor." Kramer finds evidence of this process in Beethoven's sketches for the "Tempest" Sonata, op. 31, no. 2 (1802), which reveal that "the act of writing is itself an improvisational reach for the idea that needs to be coaxed from the hidden recesses of the imagination."¹⁹⁴ While the mediation of such ideas "relies on the piano as a sounding-board," Kramer reads both the sketches and the opening bars of op. 31, no. 2, in their final form to signify the improvisatory process by which the sonata (or rather the Sonata) comes into being: the off-onic opening does not merely "play within the ground rules of genre," but rewrites them.¹⁹⁵

Whereas the "Tempest" is cast in a self-consciously tragic mode, it is book-ended by sonatas in G major (no. 1) and E flat major (no. 3) that strike an overtly ludic tone. (It is noteworthy that all three were commissioned by Nägeli, an outspoken proponent of music's playful qualities, for publication in his ambitious "Répertoire des clavecinistes" series.)¹⁹⁶ Affective disparities notwithstanding,

each sonata in the op. 31 set plays with the rhetorical and gestural lexicon of commencement. If no. 2 ostentatiously raises the curtain, then no. 1 brings it down with a thump, barking out a seemingly definitive answer that proves to be decidedly questionable. In this context, Claudia Maurer Zenck invokes Michaelis's description of "humorous" music that "begins in such a peculiar way, perhaps extremely simply, with some notes that appear insignificant, that one would not have suspected the interesting and amusing work that develops."¹⁹⁷

The same could be said of no. 3, which steals upon the ear *in medias res* (Figure 71, Audio 16) to "set in motion . . . an amusing game," as Michaelis characterized such strategies.¹⁹⁸ In stark contrast to the tenebrous vocality and mercurial affective shifts of the "Tempest" Sonata, much of which is redolent of C. P. E. Bach's fantasias, this opening Allegro is firmly grounded in a *galant* idiom, evinced by stylistic markers such as the brisk *Trommelbaß* (m. 17f.) and the subsequent Alberti figuration that powers the movement once it is up and running (m. 46f.). Yet its slyly playful opening seems calculated to raise eyebrows and furrow foreheads: despite Czerny's parsing of the opening gesture as a "question," it does not so much pose a riddle as attempt to come to terms with an unstated conundrum.¹⁹⁹

The confusion thereby sown can be measured by the range of critical responses this music has prompted, which fail to reach consensus on even the most basic issues of syntax and character. Whereas Barry Cooper hears the opening to set a "capricious and light-hearted tone" that pervades the whole sonata and Robert Taub delights in the "good-humored, quizzical, unsettled sensation" it stimulates in the performer, Charles Rosen took the opening gambit more seriously, describing the sonata's initial measures as "emotionally the most unsettling that Beethoven had written."²⁰⁰ Regardless of their affect, these measures can be heard to enact a hypotactic process that gradually rationalizes the problematic condition(s) in and under which the sonata enters the audible realm. At the hands of the performer, this process is dramatized as the operation of a ludomusical feedback loop: the sonata's affordances and constraints are determined and tested via the rule-bound interplay of utterance and response, which listen and adjust to each other in turn.

After the reiteration of the opening measure, constants and variables are systematically permuted, tentatively extending the musical counterpart of a "word ladder."²⁰¹ First, the harmonic parameter is kept constant while the rhythmic profile is transformed (m. 3); subsequently, the rhythm stays constant while the harmonies shift (mm. 3–6); and finally, once the relative security of a tonic 6/4 chord has been gratefully grasped, the left hand continues in the same rhythmic pattern (mm. 7–8) while the right hand performs the cadential formalities with a flirtatious shimmy.²⁰² Belatedly arriving at what should have been the sonata's point of departure, it simultaneously launches the first of the movement's increasingly extravagant roudades, mock-operatic *fioritura* perhaps belatedly triggered by the familiar prompt of a fermata over a 6/4 chord in m. 6. The stumbled-upon 6/4 also

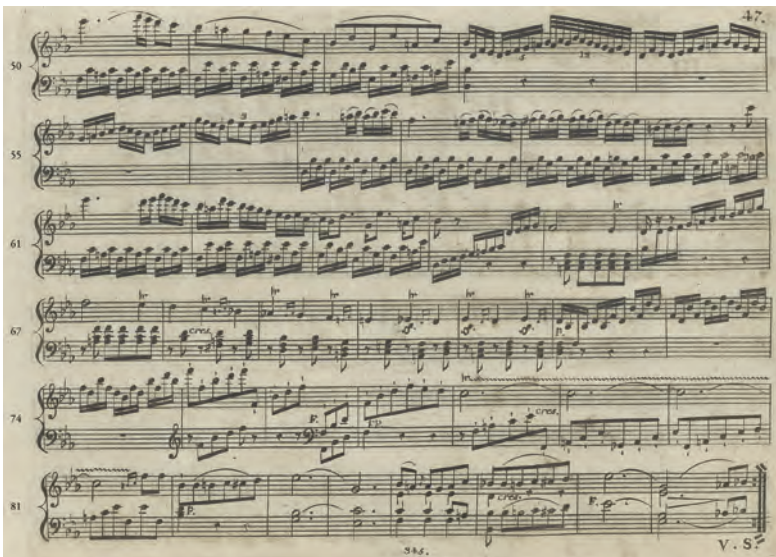
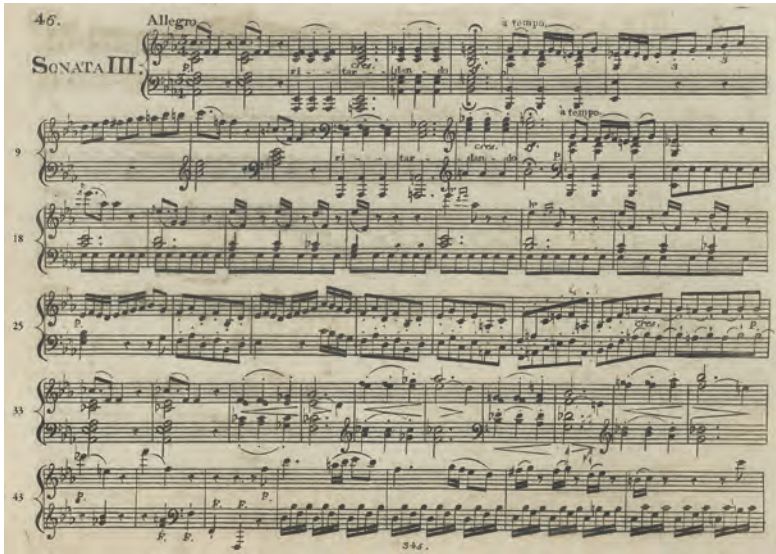


Figure 71. Ludwig van Beethoven, Piano Sonata in E flat, op. 31, no. 3, i, mm. 1–88 (Bonn and Paris: Simrock, 1804). Reproduced by permission of the Beethoven-Haus Bonn (Collection H. C. Bodmer).

Audio 16. Beethoven, Piano Sonata in E flat, op. 31, no. 3, first movement, performed by Malcolm Bilson (fortepiano after Johann Schantz [ca. 1795] by Thomas and Barbara Wolf [1991]).



To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5254/uminos.16.24>

constitutes archaeological evidence that the *cadenza composta di salto* (Example 2) is the guiding protocol behind this stepwise sequencing of events.²⁰³ The entire sequence is then repeated with the introduction of an additional parameter: octaval transpositions partition the keyboard into distinct registral zones (a tactic that will later be deployed with ludicrous rigor to herald the arrival of the polonaise-tinged second theme and to pull the rug out from under the would-be graceful footing of the Minuet's Trio).²⁰⁴

Despite the growing confidence with which the additive procedures of these opening sixteen measures harden into a quasi-syllogistic logic, the suspicion remains that something is awry. The problem lies not so much in what is written as in what is not. From the very outset, why does the music seem to be laboring toward a close? What might we have failed to hear—or to imagine having heard? These puzzling questions are encapsulated by the ambiguity of the sonata's opening chord. From Rameau's *double emploi* to Gjerdingen's *indugio*, theorists have accounted for the classification and function of this sonority in contrasting ways: while some, including Schenker, considered it to be an inverted supertonic seventh chord, others, such as Riemann, apprehended it as an altered subdominant chord.²⁰⁵ Among this latter group can be counted the plain-speaking Donald Francis Tovey, who claimed that the "honest old empiric name of 'Added Sixth' correctly describes the chord. . . . Its present bass is A flat, which, in the judgment of human ears, as distinguished from abstract theories, may pass for its 'root.'"²⁰⁶ When confronted with the looping arpeggios that herald the recapitulation (mm. 128–39, Figure 72 and Audio 17), however, Tovey tempered his bluster, acknowledging that the opening figure "flats in over the F minor 6th on A flat. So the famous opening chord now becomes a chord of the added 5th."²⁰⁷ In other words, the pitch of E flat—the tonic itself—becomes a foreign element at the very moment of its anticipated return.

Rather than passing judgment on whether the opening chord is either an inverted F-minor seventh chord or an A-flat triad with an added sixth, we might consider it as an amalgam of both, a sonic double exposure composed of the perfect fifths (A flat–E flat and F–C) that outline each sonority, which combine to inflct the opening with the pastoral evocation of a musette.²⁰⁸ These elements are subtly separated just before the recapitulation in the manner of a harmonic chromatogram: the active agent is the voice that chromatically ascends from E flat₃ to F₃ via E natural₃ (mm. 128–30), articulating a shift from an A-flat-major to an F-minor triad.²⁰⁹ The process of recapitulation thus sheds light on the formation of the movement's opening by anatomizing its construction. It allows us to hear the chromatic rise of the outer voices in mm. 139–42 (and, retrospectively, in mm. 3–6) as the continuation of a process that lies latent within the opening sonority rather than as a distinct generative strategy.

In the interim, this process can be tracked over the course of the exposition; beyond that, it extends across the movement's primary formal caesura, the double-barred point at which it is spatially and temporally divided in two (m. 88).

Figure 72. Beethoven, Piano Sonata in E flat, i, mm. 128–81. Reproduced by permission of the Beethoven-Haus Bonn (Collection H. C. Bodmer).

Audio 17. Beethoven, Piano Sonata in E flat, i, mm. 128–44, performed by Malcolm Bilson.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.25>



Precisely where the exposition is subjected to the most conventional mode of replication, repetition becomes revelatory rather than redundant. The strategy is foreshadowed by the plain *fi* st-inversion chords in mm. 83–84, which anticipate the recapitulation in articulating the separated-out harmonies of the local subdominant (m. 83) and supertonic (m. 84) that are overlaid, transposed down a *fi* h, in the opening measure. The subsequent reiteration of the right hand's dotted half notes in mm. 87–88 endows them with a thematic quality: doubled by the left hand and now outlining a pure E-flat sonority, they assume the guise of the missing melodic and harmonic tonicization that went unplayed and unheard the *fi* st time around.

With mm. 87–88 tacked in front of them (Figure 73, Audio 18), the repeated mm. 1–8 *fi* ally become comprehensible as a thematic gestalt that conforms to the generic norms of opening gambits pursued elsewhere by Mozart as well as

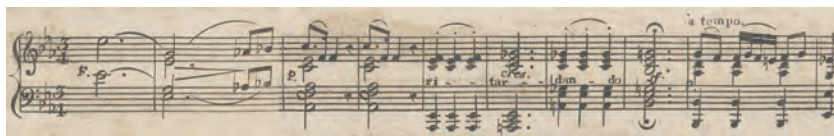


Figure 73. Opening measures of Beethoven, Piano Sonata in E flat, i, as heard at the repeat of the exposition (mm. 87–88, 1–8). Reproduced by permission of the Beethoven-Haus Bonn (Collection H. C. Bodmer).

Audio 18. Beethoven, Piano Sonata in E flat, i, mm. 87–88, 1–8, performed by Malcolm Bilson.

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Beethoven.²¹⁰ Perhaps most importantly, the E flats in m. 88 restore the puzzling remnants of the opening *cadenza composta di salto* to working order, rationalizing the dissonance in m. 1—and, by implication, its counterpart that puzzled Tovey in m. 139—as the by-product of their suspension.²¹¹

If further proof were required of the thematic substance and consistency of this newly constituted theme, it might be placed alongside the movement's second theme, which is more directly comparable in its recapitulatory guise (Figure 72, m. 170f.). Here, the intervallic outline of mm. 83–84 and 87–88 (which had been adumbrated as early as m. 19) is echoed an octave higher: the chirps of mm. 172–73 outline the descending fifth of mm. 1–2, while the thumb of the left hand reenacts the recapitulatory chromatic ascent that transforms an A-flat-major into an F-minor triad (here even treated canonically within the Alberti texture from mm. 172–74). Although the consequent phrase takes a different trajectory in mm. 174–76, it returns to the tonic via an analogous *clausula perfecta* after a brief detour occasioned by a *cadenza finta*.²¹²

The two themes also share the same design insofar as they consist of two distinct iterations of the same cadential pattern separated by a monophonic melisma in the soprano register. Furthermore, as suggested by Adolf Bernhard Marx and subsequently pursued by Nathan L. Fishman in his edition of the Wielhorsky sketchbook, the origins of the second theme can be traced by considering it in rhythmic parallel with the material derived from the opening gesture that unfolds over the *Trommelbaß* (m. 18f).²¹³ The repeat of the exposition thus reveals the first theme to be a schematic outline of the second, and vice versa. As the unheard is sounded and the imaginary rendered concrete, the missing riddle is simultaneously posed and answered.

While all repeats are in a sense unprecedented, the closing of the feedback loop between mm. 88 and 1 recursively completes and reinitiates the process of parametric transfer pursued at the movement's outset. Traveling back to the exposition's origin reframes its destination; at the same time, the audible future reveals its inaudible prehistory.²¹⁴ Left to its own devices, the exposition could loop indefinitely, as m. 89 intimates. Like the flapping of a butterfly's wings, however, m. 91's subtle departure

from m. 3 suffice to open up an alternative musical destiny. Both procedures indicate how Beethoven's sonata format defies both the linearity of its presentation on the page and the temporality of its performance at the keyboard, reconfiguring the musical manipulation of space and time via techniques that would have to wait for newer media to provide them with names: not only loops, but also cross-cuts, wipes, fades, replays, and even retroactive continuity. On the one hand, the ambiguous playfulness of op. 31, no. 3, emerges from its reliance on the distinctive clarity of its eighteenth-century materials; on the other, its manipulation of these elements displays features associated with the technical mediation of autopoietic emergence.

The sonata's feedback loops also exhibit a new order of reflexivity, an awareness of self-awareness that echoes through history like Beethoven's sardonic laughter at the expense of hapless performers and listeners.²¹⁵ Is the keyboardist conspirator or stooge, player or toy, joker or butt?²¹⁶ Compelled to observe his or her own observation of the sonata's *galant* cues, which stand at an ambiguously ironic distance from the musical protocol of an *ancien régime*, the performer demonstrates its operational closure in the very process of becoming hermeneutically coupled to it.²¹⁷ As Kramer writes of op. 31, no. 2, those who wish to play (with) Beethoven's music must simultaneously divine the rules of the game.²¹⁸

In what might be construed as a Romantic rejoinder to Bernard le Bovier de Fontenelle's bafflement at what a sonata might possibly want of him, Hoffmann decisively shifted the burden of responsibility: "What if it is only *your* inadequate understanding which fails to grasp the inner coherence of every Beethoven composition? What if it is entirely *your* fault that the composer's language is clear to the initiated but not to you?"²¹⁹ Commentators on the op. 31 sonatas have often seized on evidence to support the contention that Beethoven aimed therein to pry open a gap between the detritus of the generically combinable elements that had composed the *galant* style and the forging of a distinctly new idiom, at once idiolectal and universal.²²⁰ In a sense, however, Beethoven was simply adhering to the terms of his commission: despite the archaic ring of its title, Nägeli touted his "Répertoire des clavecinistes" as a series featuring "solos in the grand style, of great scope, with many departures from the usual sonata form," which he solicited from such luminaries as Jan Ladislav Dussek, Johann Baptist Cramer, and Daniel Steibelt alongside Beethoven.²²¹ We might thus consider the work's eighteenth-century pedigree to coexist with imperatives of originality, complexity, and ambition in terms that do not issue solely from the vantage point of Beethoven's subjectivity.

Beyond the role played by op. 31, no. 3, in the articulation of Beethoven's compositional development, how was its playful problematization of listening and performing materially mediated? A point of departure for such inquiry was flagged up by Riemann, who, in the course of accounting for the sonata's tantalizing opening sonority, located its source of expression in the eighteenth century: his description of the opening motive as "a true Mannheim sigh" nods to the *galanterie* of



Figure 74. Hugo Riemann, *L. van Beethoven's sämtliche Klavier-Solosonaten* (Berlin: Max Hesses Verlag, 1919–20), 2:427.

Johann Stamitz.²²² As well as tracing a compositional genealogy, Riemann was concerned with the Mannheim school's transformative approach to the medium of musical delivery, which he addressed in terms of keyboard technique, specifically the *Staccatospiel* promoted by eighteenth-century instruments, pedagogy, and aesthetics.²²³ (The issue of instrumental medium takes on greater definition in light of the care Beethoven took to fit the op. 31 sonatas within the compass of a five-octave keyboard, the physical limits of which are made amusingly explicit in mm. 44–45.)

For Riemann, as Scott Burnham stresses, the sonata's meaning could not be decoded from the score alone: it had to be demonstrably conformable with his own theory of phrase structure and its articulation via iambic hypermeter.²²⁴ Beyond an archaeological approach to gesture, this necessitated reading (and writing) between the lines of Beethoven's notation in order to convey what Riemann perceived as the opening figure's refusal to be confined by slurs, bar lines, the acoustic properties of the instrument (witness the crescendo that accumulates over the course of a rest in Figure 74), and even its own repetition in order to "arrive" on the hypermetrical downbeat of the second measure.²²⁵ Riemann's neumatic rewriting of Beethoven's opening gesture charges it with communicative urgency, transforming it into a signal that demands an interpretive response.²²⁶

Glossing Goethe and Schiller, Kittler identified the sigh (*ach!*) as "the sign of the unique entity (the soul) that, if it were to utter . . . any signifier whatsoever, would immediately become its own sigh of self-lament; for then it would have ceased to be soul and would have become 'Language' instead."²²⁷ In this light, Riemann's imaginary performance of Beethoven's Mannheim sigh, instrumentally liberated from all traces of its linguistic armature, represents its own unrepresentability: each iteration is not the index of an author's sentiment, but the actualization of the affect at which even *ach!* can only hint.²²⁸ Such wordless sighs cannot be disentangled from musical representations of "the secret harmonies of nature" that Hoffmann "limned so effectively with the precision of *words*," as Ferruccio Busoni expressed it.²²⁹ Beethoven himself was also fluent in this discourse: "No one can love the country as much as I do. For surely woods, trees, and rocks produce the echo that Man desires to hear."²³⁰

This suggests one more way of hearing the opening of op. 31, no. 3, first noted by Jacques-Gabriel Prod'homme in 1930.²³¹ In place of Riemann's perception of a Mannheim sigh, Prod'homme heard the dotted rhythm to represent the call of

the quail (Audio 19), which was explicitly invoked by Beethoven in his setting of Samuel Friedrich Sauter's "Der Wachtelschlag," WoO 129 (1803). This song, along with the depiction of the quail in the "Pastoral" Symphony, op. 68 (1808), accords with Hoffmann's image of the composer as nature's sounding board: Beethoven purportedly told Anton Schindler that the *Szene am Bach* was composed on location while "the goldfinches up there, the quails, nightingales, and cuckoos circling around composed along too."²³² Beethoven's pantheistic fervor imbued environmental acoustical phenomena with creative significance, for birdsong was nothing less than nature's performance of improvised composition.

Accordingly, throughout "Der Wachtelschlag" the quail's call is underlaid with religious sentiments: *Fürchte Gott* ("Fear ye God"), *Liebe Gott* ("Love ye God"), and *Lobe Gott* ("Praise ye God"). The variation of melodic, harmonic, and rhythmic details in both vocal and keyboard parts transduces its cry into the realm of human expression, modulating each repetition into a meaningful utterance.²³³ In this light, we might construe the discursive desperation of the "Heiligenstadt Testament," written in close proximity to op. 31, no. 3, and "Der Wachtelschlag," as an attempt to endow the intransigent and inhuman world with a spiritual significance accessible via hermeneutical divination rather than raw sensation.²³⁴

While the quail could articulate the wondrous mysteries of creation, however, its relentless ostinato also carried connotations of toylike miniaturized automation, as David Wyn Jones notes.²³⁵ The tradition of simultaneously mechanizing and infantilizing birdsong passes through the "Toy Symphony" variously attributed to Haydn and Leopold Mozart as well as Bernhard Romberg's "celebrated Toy Symphony," more properly known as the *Symphonie burlesque*, op. 62 (ca. 1825), which included a prominent part for *Wachtelpfeife* ("quail whistle," Figure 75).²³⁶ If, with Prod'homme, we hear the first movement of op. 31, no. 3, to channel a quail, Carl Reinecke's observation that the opening rhythm recurs about one hundred times throughout the movement becomes less a reflection of Beethoven's ingenious motivic economy and more a Rombergian acknowledgment of bird-brained obstinacy and redundancy.²³⁷

When quantizing the pitch of the quail's call as F_4 and its rhythm in the terms of what would become its standard dotted notation in his *Musurgia universalis*, Kircher transcribed its acoustic signature as the resolutely unpoetic "bikebik" (Figure 76); conversely, he credited the parrot perched next to it not merely with the capacity of speech, but with conversational fluency in ancient Greek.²³⁸ In a manner at once frivolous and profound, Kircher thus depicted two modes by which avian feedback loops could be incorporated into the mimesis of audible discourse, represented by the meaninglessness of the quail's musical repetition and the parrot's anthropic ability to make linguistic sense. In Beethoven's day, these communicative channels were blended by Sauter's earnest religiosity as well as by Hoffmann's pantheism.²³⁹ From this perspective, we might understand Beethoven's

TOY-SYMPHONY.

1

Allegro maestoso. QUAIL. B. Romberg.



Figure 75. Bernhard Romberg, *Wachtelpeife* part from his so-called “Toy Symphony” (*Symphonie burlesque*, op. 62), i, mm. 1–49 (London: Augener, ca. 1880 [composed ca. 1825]).

Figure 76. Kircher, detail from *Musurgia universalis*, 1:30.

Audio 19. Field recording of the common quail (*Coturnix coturnix*), made in Dahme-Spreewald, Brandenburg, by Sonnenburg (2015). CC BY-NC-SA 4.0.

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imaginative modulation of the quail's "rigid monotone drone" throughout op. 31, no. 3, to mark a transformation through which both the natural and the mechanical become infused with expressive potential: by elevating the initial pitch of the quail's F_4 monotone by a perfect fifth, Beethoven transforms it into a Mannheim *ach!*²⁴⁰ Nowhere is the quail's sigh more affecting than at mm. 33–34, where the C_5 is flattened by a poignant dash of modal mixture: the ardently rising harmonic sequence that ensues conjures a prototype of that most enduring symbol of Romantic longing, the "Tristan" chord (m. 36f.).²⁴¹

Yet if we neglect the sheer playfulness with which this sonata disguises, dissembles, defers, and delays proceedings by way of deadpan repetition, hesitant exploration, and finally "a flurry of excited clatter that motors around through the registers," as Burnham aptly characterizes it, we find ourselves aligned with Riemann's straight-faced mission to "rid artistic creation of every vestige of caprice and make it into a logically necessary imperative."²⁴² The set of seven bagatelles that Beethoven gathered together and issued as op. 33 (1803) in the wake of the op. 31 sonatas gives the lie to Riemann's lofty rhetoric. Several play whimsical games with slapstick elements that also stud op. 31: absurdly flippant passagework, derailed processes that require a kick-start, casual oscillations between outlandish keys, rhythmical and registral bumps, thuds, and collisions, and comically desynchronized hands abound.

The indoor table game of bagatelle, a forerunner of pinball and pachinko in which players aim to guide balls into holes guarded by wooden pegs, swept through Europe toward the end of the eighteenth century. Although it is possible that Beethoven named his set of pieces after this ludic pursuit, it seems more likely that, after the fashion of François Couperin's rondeau "Les bagatelles" (1717), he chose the term simply to indicate his pieces' trifling scale and lack of pretension. That notwithstanding, the Bagatelle in C, op. 33, no. 5, evokes its ludic namesake in its pinball-like simulacrum of acceleration and inertia.²⁴³ Initially propelled upward as though by a plunger, the "ball" slowly descends via musical bumpers and spinners before being flipped up eleven times more. On the final occasion, however, it gets stuck (m. 58f, Figure 77 and Audio 20), forcing the player to tilt the machine with increasing force. It is telling that, in harmonic terms, this sticking point is identical to that encountered just before the recapitulation in the final movement of op. 31, no. 3: the obstacle consists of a subdominant chord (implied throughout mm. 59–63) that needs to be chromatically nudged into a first-inversion supertonic chord in order for the music to proceed to the cadence.²⁴⁴

The overt playfulness of this mere bagatelle does not detract from the high seriousness of Beethoven's music writ large; on the contrary, the distinction between Mozartian and Beethovenian play lies in the dialectical distance from which the latter observes the former, strategically deploying it as a token in a game of Schillerian loftiness. Beethoven's bagatelles are fragmentary in the Romantic manner of a sonic Schlegelian hedgehog, at once irrevocably implicated in and defiantly

Figure 77. Beethoven, Bagatelle in C, op. 33, no. 5, mm. 54–72 (Vienna: Bureau des Arts et d’Industrie [1803]). Reproduced by permission of the Beethoven-Haus Bonn.

Audio 20. Beethoven, Bagatelle in C, mm. 54–72, performed by Shin Hwang (fortepiano after Johann Schantz [ca. 1795] by Thomas and Barbara Wolf [1991]).



To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.28>

isolated from the play of the world.²⁴⁵ This music plays with play, interrogating the ludic logic of mimesis by constructing feedback loops that yield unpredictably emergent results: in the terms that Hoffmann brought to bear on the Fifth Symphony, its first-order “genius” is observed by second-order “awareness.”²⁴⁶

It is in this sense that the matter of Beethoven’s deafness can be brought to bear on the mediation of play at the keyboard.²⁴⁷ What remains unheard at the beginning of op. 31, no. 3, thereby eluding Tovey’s “judgement of human ears,” and what gets stuck in op. 33, no. 5, testify to a form of deafness defined not only as a spiritual crisis to be overcome, but also as the material obstruction of a communicative channel.²⁴⁸ For Beethoven at the turn of the century, deafness could take the form of a low-pass filter (“at a distance I cannot hear the high notes of instruments or voices”) or the inability to hear at all (“What Mortification if someone stood beside me and heard a flute from afar and I heard *nothing*”).²⁴⁹ The issue of audibility created its own feedback loops that coursed within and between bodies. This made it possible to conceive of the “unheard” as a function of repetition

within an individual work, as indicative of sonorous intertextual relationships that span broader repertorial and sonic networks, as a condition that constructs (and is constructed by) a sovereign subject who imposes narrative order on musical events, and as a material artifact of Beethoven's malfunctioning auditory system. As revealed by his attempts both to keep that channel open and to bypass it via all available technological means, its obstructions could be at once constituted and mitigated by the writing of notes or the pressing of keys.²⁵⁰ In all these senses, op. 31, no. 3, can be heard as a recursive "discourse on discourse channel conditions," in Kittler's phrase: it establishes its mode of transmission by calling it into question, and vice versa.²⁵¹

After the "Emperor" Concerto, the function of the keyboard was to shift again for Beethoven. Although it no longer served as a medium for public performance or improvisation, its deployability as a compositional prosthesis was complemented by its capacity to amplify sound as his hearing deteriorated. The Broadwood piano he received as a gift in 1818 was subsequently fitted with devices designed by Matthäus Andreas Stein and Conrad Graf; operating according to the same principles as a phonograph horn, Stein's tin cupola fed back the instrument's sound to Beethoven's ears as he composed his final piano sonatas.²⁵² The recursion of this feedback loop blurred the distinction between digital input and analog output, between the generation and recreation of Beethoven's single-player games. The question of how this music is to be imagined, contemplated, heard, and reenacted continues to be motivated by the epiphanic moments that can arise from hermeneutical processes, but it also entails media-archaeological inquiry into the conditions that make these phenomena imaginable: notational systems, instrumental interfaces, sonata formats, tin cupolas, ear trumpets, and the physiological networks that have filtered and processed the audible world in order to render it playable.

"I am an altogether patient thing, I let myself be used by everyone. Though me the truth, the lie, erudition, and stupidity are proclaimed to the world."²⁵³ So begins Mozart's second Zoroastrian riddle. The answer lies not within the sender, or the receiver, and is not even encoded in the signal, but is enmeshed in the communicative channel itself, the very medium by which the riddle was inscribed, replicated, and disseminated: paper.²⁵⁴ In musical as well as ludic terms, scores rendered on paper give essential yet incomplete information, a rough outline of the improvised, performed, and replayed actions they prompt or reflect. Witnessing the emergence of what would later be cataloged as Mozart's K. 454 from a virtually empty page, Joseph II might have been confounded by the concept of music that was heard but not seen; the score of Beethoven's op. 31, no. 3, conversely, makes visible what goes unheard at its outset.²⁵⁵ In both cases, the score alone cannot account for how the compositional game was played or how it might be replayed in performance.

Yet while Mozart's notes on paper are readily apprehended as rules or scripts, Beethoven's scores have been revered as unbreakable records rather than read as invitations to join the ludomusical fray.²⁵⁶ Reified in the authoritative form of the *Fassung letzter Hand* and enshrined in the musical Hall of Fame, Beethoven's keyboard works helped set the nineteenth-century standard by which music could transcend material limitations, revealing itself to be better than it could possibly be played.²⁵⁷ Concomitantly, and in line with the misgivings expressed by Herder and Hegel, the Schillerian currency of play was devalued and its stature diminished. Instead of being celebrated as a vital cultural force, play became associated with the second-order functions of recreation and remembrance, the affective tone of which could easily shade into childishness and sentimentality. Stored as canonical highlights and cherished keepsakes, musical scores were played *back* as a means of emulating or revisiting the past, whether construed as a glorious cultural heritage, as halcyon days to be nostalgically relived, or both at once.²⁵⁸

As a vehicle of personal and cultural memory, recreative play at the keyboard might nonetheless be heard not only to supplement its improvisatory and performative counterparts, but also to syncopate the phonographic emphasis with which the history of recording and reproduction has most commonly been recounted.²⁵⁹ Today, moreover, the interface of the keyboard continues to provide conceptual and material access to human and mechanical modes of digital recreation that recursively index these historical functions in contemporary terms, reformatting the past to make it replayable in the present. These modes are both addressed and adopted by this book's fifth and final Key.

Key 5

Play Again?

In Beethoven's wake, the ubiquity of play at the keyboard led to an unprecedented degree both of standardization and of specialization. Despite significant local variation in procedures relating to manufacture and pedagogy, the gradual homogenization of pianistic hardware and its installation across an ever-growing domestic user base allowed for the transmission and mobilization of skills, services, and software that permeated geographical and cultural boundaries. At the same time, the establishment of a relatively consistent playing field placed the onus on each individual pianist to carve out a distinctive niche in what was becoming an increasingly competitive professional environment. Augmenting the improviser-composer-pianist model adopted by Mozart, Beethoven, and their contemporaries, players such as Liszt forged their reputations on the virtuosic performance of technical feats that defied imitation and, reciprocally, on transcriptive feats of imaginative compression that proved both instrument and individual equal to the most daunting operatic and symphonic demands.¹ For Liszt, *réminiscences* of operas involved reordering their sequential elements as well as the virtuosic variation, elaboration, and remixing of their most popular numbers into a highlight reel to be (re)played on demand.² Adopting a contrasting approach, Clara Schumann was perceived to eschew novelty and spectacle in favor of putting virtuosity to work and dutifully recreating the masterpieces of the burgeoning canon, a ritual she performed by heart.³ Each distinctly implicated in the sensual and affective operations of memory, Liszt's exuberant displays and Schumann's faithful reproductions defined parameters of the piano recital's recreative blend of the past and the present that persist to this day.

But at the keyboard, as we have heard and seen, matters are rarely as black and white as they appear. Despite their considerable differences, the historical figures of Liszt and Schumann are sufficiently complex and contradictory to resist such typecasting: Liszt could claim fidelity to the letter as well as to the spirit of Beethoven's scores, while Schumann featured her own improvisations and compositions on her concert programs.⁴ More telling is the fact that a single instrumental medium could sustain such divergent practices and ideologies, proving itself adequate to the task of relaying all manner of musical utterances via digital actions and analogical gestures. Their aesthetic differences notwithstanding, Liszt, Schumann, and every other nineteenth-century pianist plied their art by way of a materiality that they were expected to transcend.⁵

All media define the limits of the reproducible as well as the imaginable and the communicable. As touched on in Key 4-1, Adorno's philosophy of musical reproduction was founded on the observation that music's "true character as writing" was revealed via the mimetic tracing of its seismic peaks and troughs by the phonograph's stylus.⁶ These oscillographic patterns, self-evidently uncoded and yet veiled from human comprehension, were akin to those formed both by Chladni's experiments and by the "mysterious mosses and herbs" that somehow register the "beautiful song" that the father of Hoffmann's *Kapellmeister* Kreisler "sang almost every day."⁷ In notational terms, the sonorous illegibility of Beethoven's sketches perhaps comes closest to matching the hermeneutic potential with which musical writing could be charged. For Adorno, such inscriptions formed a neumatic substrate to be transduced by needles, performers, and other media; beyond composition, however, the process of interpretation was itself "the perfect imitation of musical writing."⁸

This suggests a reason why even relatively scrupulous nineteenth-century editors of "classical" works felt the need to supplement the melographic plotting of pitch and rhythm, not to mention the numerical shorthand that had served seventeenth- and eighteenth-century musicians so well, with analog sweeps connoting phrasing and digits that choreographed manual gestures via unambiguously denoted fingering.⁹ Beyond the mitigation of historical or stylistic unfamiliarity in the interest of appealing to a broad constituency of readers and players, such generic markers of idiosyncrasy were understood to bring the text asymptotically closer to the conditions of its performance.¹⁰ As Kinkel's tribute to Chopin and Riemann's editorializing of Beethoven's op. 31, no. 3, makes opaquely clear (Figure 74), the meaning of notes had to be read between the lines constituting bar and stave; correspondingly, its tangible intangibility had to be digitally realized between the cracks that defined and defiled the continuum of the keyboard.¹¹

For Kittler, media provided the psychic wherewithal by which modern subjectivity was made conceivable and representable: gramophone, film, and typewriter formed a mediological triad to be mapped onto the Lacanian registers of the real, the imaginary, and the symbolic.¹² At times, the schematicism of this overlay

occludes the extent to which these strands were intertwined. In particular, as we saw in Key 2–3, the piano combined digital and analog elements associated with both Apollonian typewriter and Marsyan gramophone, with the symbolic processing of musical information and its mimetic realization. Contiguous both with Scott de Martinville’s oscillographic lexicon of nature’s “written general language of all sounds” and with Hoffmann’s alphabetically discrete invocations of such phenomena, the nineteenth-century piano was complicit in an ideological and technological quest to make the spirit audible through the very artificial and mechanical means that Rousseau, Herder, and Hegel had decried.¹³ Rather than adapting and conforming to the properties of the instrument, the musical subject at the keyboard was heard to project herself through the production of an inimitable sound that served as a sonic signature: ludic fungibility was trumped by the manifest destiny of both the work and the individuals who brought it forth, preserved for posterity on cylinders and disks.¹⁴ The deadly seriousness of such enterprises was captured by the sober tone in which Edison projected the phonograph’s capacity to preserve “*the last words* of the dying member of the family—as of great men.”¹⁵

The impersonality with which personality could be technologically conveyed promised—or threatened—to diminish the significance of composers, as Adorno grimly acknowledged and recent developments in sound and media studies have borne out: “If at some later point, instead of doing *Geistesgeschichte*, one were to read the state of the cultural *Geist* off of the sundial of human technology, then the prehistory of the gramophone could take on an importance that might eclipse that of many a famous composer.”¹⁶ Yet insofar as the history of sound recording has identified the phonograph as a paradigmatic technological breakthrough, it has covertly endorsed values based on poetic configurations of fidelity, fatality, and the preservation of selfhood that are more revealing of Hegelian historicism and Edison’s auto-mythologizing than the immediate conceptual and technological circumstances from which the device emerged.¹⁷ From before Hoffmann’s day right up until our own, however, the reification of sound as an inscrutable and inviolable form of indexical inscription to be reproduced analogically has been supplemented by digital modes of recreation that make no attempt to conceal the artifice of contrivance (and vice versa). Via the strategic deployment of pegs and pins, the tripping of keys, or the flipping of bits, digital technologies from the music box to Ableton *Live* open sonic events to playful manipulation and intervention, allowing players not only to play them back but to *recreate* (with) them.¹⁸ Vilified as crudely inexpressive on account of the simulative play they exhibit, such mechanisms have often been deemed childish and jejune by comparison to the serious business of artistic (re)production.¹⁹ Viewed from a different angle, however, their unsentimental playfulness speaks truth to aesthetic power: the *mimicry* of the *mimos* underpins the loftiest mimesis, exposing the contingency of even the most earnest attempts to model and capture sonic reality.²⁰

If children themselves were only made aware of the keyboard's capacity to recreate musical visions, Adorno fondly supposed, they would soon "tire of tootling and join forces to spell out Beethoven sonatas."²¹ Conversely, Adolf Bernhard Marx recognized the value in granting children the freedom to

play around on the piano in their own way, to seek out sounds, even to clatter over the keys (without damaging the instrument). Once lessons have begun, this kind of play is mostly suppressed: children are told that devoting themselves to finger exercises and written-out pieces is more productive. But if this singular and indispensable freedom be denied, how can the vulnerable musical imagination [*Tonphantasie*] of each child be sustained?²²

Rather than restricting them to the development of technique and the dutiful recitation of texts, Marx encouraged children to explore the keyboard's sonic resources by running, jumping, and scrambling over its uneven terrain.

In recent years, György Kurtág's *Játékok* ("Games"), an ongoing collection of "pedagogical performance pieces" begun in 1973, have perhaps best manifested the childlike *paidia* of this type of play at the keyboard, the recreative gestures of which both prompt and reflect a cornucopia of visions, associations, and recollections. Echoing Marx, Kurtág recounts that the composition of *Játékok*

was suggested by children playing spontaneously, children for whom the piano still means a toy. They experiment with it, caress it, attack it and run their fingers over it. They pile up seemingly disconnected sounds, and if this happens to arouse their musical instinct they look consciously for some of the harmonies found by chance and keep repeating them. . . . Pleasure in playing, the joy of movement—daring and if need be fast movement over the entire keyboard right from the first lessons instead of the clumsy groping for keys and the counting of rhythms—all these rather vague ideas lay at the outset of the creation of this collection. Playing—is just playing.²³

A set of twelve miniaturized depictions of toys and games for piano duet, Bizet's *Jeux d'enfants* triangulates the playfulness advocated in Marx's and Kurtág's ludopedagogical statements while forming a chronological link between them that belies the notion of the nineteenth century as a no-play zone.²⁴ Among them, perhaps the most thoroughly—even tautologically—playful gestures are choreographed in "Saute-mouton" ("Leapfrog"), subtitled "caprice." Here, the eponymous pursuit accounts for the genre and mode of performance as well as the musical subject matter, at which the score or a recording can offer only the faintest hint.²⁵ Each hand leapfrogs the other at the outset (Figure 78, Audio 21), while the hand-off between the two pianists in m. 2 turns proceedings into a two-player game. Starting and ending at opposite ends of the keyboard, the leapfrogging multiplies at mm. 21–24 as if reflected in a mirror (Figure 79, Audio 22): for the players, the chiasmic intersection in the middle plots collisions between the hands of self and other that must be negotiated with quick-witted agility.

Allegro molto moderato

Allegro molto moderato

Figure 78. Georges Bizet, “Saute-mouton” from *Jeux d’enfants*, mm. 1–4 (Paris: Durand, Schoenewerk & Companie, [1872]).

Audio 21. Bizet, “Saute-mouton,” performed by Shin Hwang and Roger Moseley (Steinway Model D [1908]).

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.29>



Figure 79. Bizet, “Saute-mouton,” mm. 21–24 (Paris: Durand, Schoenewerk & Companie, [1872]).

Audio 22. Bizet, “Saute-mouton,” mm. 21–24, performed by Shin Hwang and Roger Moseley.

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.30>





Figure 80. *Pinball Pianola* (2012), devised and constructed by Lucas Abela. Playful art by Keg de Souza; audio effects by Hirofumi Uchino. Photograph reproduced courtesy of Lucas Abela.

Video 9. *Pinball Pianola* in action. Reproduced courtesy of Lucas Abela.

To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5252/luminos.16.31>



Questions arise from the self-evident ludomusicality of Bizet's digital analogy: Does the Aeolian modality stage the *mimicry* of children at the piano, for whom the white keys become a literal playground for running, skipping, and jumping, or does it self-consciously invoke *paidia* by way of a calculated indifference to diatonic protocol? Throughout the piece, the breathless *ilinx* of hands and bodies alternates with the artful coordination of quasi-Wagnerian chromatic chicanery, indicating the affective ambiguity with which childhood is represented as well as reenacted.²⁶ Like Kurtág's games, Bizet's diversions are to be coyly and nostalgically observed as well as enthusiastically played: for both players and listeners, they are at once ironic and naïve, recreative and recreational.²⁷

Despite the stylistic gulf that lies between them, Kurtág's *Játékok* and Bizet's *Jeux d'enfants* activate the same playful vectors when set in ludomusical motion. The same could be said of the qualities of kineticism, inertia, pleasure, and frustration exhibited and elicited by Beethoven's *Bagatelle in C*, discussed in Key 4–5, and Lucas Abela's *Pinball Pianola* (2012, Figure 80 and Video 9), an interactive sound

installation that fuses the mechanics of an upright piano and a pinball machine in a manner designed to appeal to “virtuosos and wizards alike.”²⁸ The machine’s keyboard triggers twenty flippers that propel the ball toward the piano’s strings; the sonic results are amplified by contact microphones and processed by a range of adjustable effects and filters that are activated by way of six yellow targets studding the field of play. Uncoupling and rewiring the pianistic logic according to which digital input is directly and predictably mapped onto sonic output, the *paidia* of *Pinball Pianola* opens up a playful space between flipper, bumper, target, and string that, despite the staves adorning it, is as far removed from musical scores as it is from the scores typically accumulated in the course of playing pinball.

*From Beethoven’s bagatelles to Pinball Pianola, recreative devices and techniques form a genealogical and epistemological supplement to the dominant narrative that relates the technological mediation of sound primarily in terms of ever-increasing verisimilitude, a narrative belied over the course of recent decades by a decisive turn away from the analogical demonstration of naturalistic fidelity and toward the digital attributes of promiscuity, economy, and mobility.*²⁹ In its multiple hedonic, renovative, and restorative senses, recreation can be set alongside established modes and technologies of reproduction as a means of accounting for the generation, retrieval, transduction, simulation, playing, and replaying of sonic data. Recreation emerges from the reciprocity between visible, audible, and tangible representations of information in both space and time: it has to do with play put on display.

To reframe the playfully recursive qualities of the phenomena addressed in its four predecessors, this final Key bears witness to the performance of its own chiasmic reversal. Rather than apprehending digital games primarily as technological remediations of prior events and phenomena, this Key focuses on games developed and published by Nintendo in order to tease out elements that resonate with the musical past in unexpectedly revealing ways. Hitherto, digital games have been intermittently deployed to shed catachrestic or skeuomorphic light on ludomusical objects and practices drawn from the literate and manual traditions of Western art music. In what follows, conversely, Japanese digital games are presented in light of their capacities to process those objects and practices, which in turn assume the wherewithal to redefine the significance of digital games themselves. As a means of illustration and demonstration, digital games here replay the themes addressed in each previous Key, to which end each of the miniature Keys that follow recursively maps onto its large-scale predecessor and counterpart.

First, the concept of ludomusicality is revisited from a Nintendian perspective; second, the media-genealogical lineage of the digital analogy is retraced via recreative devices with and by which to play in Nintendo’s game-worlds, both on- and off-screen. The third mini-Key addresses the emergence of digital ludomusicality and its intersection with improvisation as artistic practice, a nexus explored by the work and play of the game developer and media artist Toshio Iwai, while the fourth examines

Nodame Cantabile's recreation of Mozart's Sonata for Two Keyboards as a competitive and collaborative endeavor pursued by students at the fictional Momogaoka College of Music, who serve as avatars for players wielding Wii remotes and *nunchuks*. Absurd though it might sound, *Nodame Cantabile* demonstrates and affords modes of ludomusical performance that, via the labyrinthine media-archaeological channels that both connect them to and remove them from the phenomena they recreate, are at once historical and contemporary. As such, the game's brazen eschewal of any pretense to authenticity and its wholehearted embrace of the playful elements that attend rituals of performance offer potential ways of (re)presenting the ludomusicality that lies latent in the high scores of the past. Finally, the Key pivots toward its resting place by recapitulating the combinatorial and recursive themes of the book writ large.

5-1 NINTENDO'S BRAND OF LUDOMUSICALITY

The tangled genealogy of the digital game resists the casual ascription of cause and effect, origin and derivation. Similar elements can be found in different ecosystems, and the perception of affinities and discrepancies is preliminary to the assembly of a method sufficiently flexible to account both for local idiosyncrasies and for the transnational logic of capitalism and control that has driven interactions within and among East Asian and Western nations since the end of the Second World War.³⁰ This task is made more challenging by the rhetoric of exceptionalism that infiltrates national discourses in response to global dynamics.³¹ From *Super Mario Bros.* to *The Legend of Zelda*, the worldwide popularity of Nintendo's evergreen franchises indicates that while the concepts behind digital games emerge under specific conditions and constraints, they can migrate freely across geographical, cultural, and technological borders.³² The systemic design and representational attributes of such games should not be essentialized as "Japanese"; at the same time, neither should the differences that distinguish them from their Western counterparts, which reflect historical circumstances and technological resources that have at times overlapped and been held in common.

According to the art historian Nobuo Tsuji, a playful shuttling between artistic whimsy and artisanal skill, decorative ornament and functional structure, and (in Caillois's terms) between the childlike ebb and flow of *paidia* and the strict observance of rules that typifies *ludus* has distinguished Japanese culture for centuries.³³ In pursuit of a "Japanese way of playing," Rupert Cox arrives at the Kantian conclusion that those who play "accept the context which constrains their action and the ludic structure which frees it."³⁴ Along similar lines, the digital-game scholar and former Nintendo developer Akihiro Saitō notes that the perception of affordances where others see constraints is characteristic of a playful mindset that pervades Japanese visual and literary culture.³⁵ In considering the autopoietic question of how relatively simple devices (such as Nintendo's Game Boy [1989]) can give rise to complex phenomena (such as the gameplay of *Pokémon Red* [1996]), Saitō invokes

the refinement, precision, and ambiguity wrought via the relatively crude technology of Edo-era woodblock prints depicting the “floating world” (*ukiyo-e*) and the intricacies that emerge from the rigorous compression of the *haiku*.³⁶ Saitō maintains that the carefully designed interfaces of Nintendo’s games draw on the spaces and rituals of *motenashi* (hospitality), such as the artful arrangement of flowers in the *chashitsu* (tea ceremony room): for him, it is no coincidence that Nintendo was founded in Kyoto, “the birthplace of Japan’s hospitality culture,” in 1889.³⁷

Miniaturization is an associated facet of play that is global in scope and yet is invested with distinct significance in Japan.³⁸ From rock gardens and *bonsai* to cars and transistor radios, operations of shrinkage, compression, and folding, related both to mobility and to microcosmic consolidation, have been central to Japanese aesthetics and cultural practice.³⁹ Akin to Huizinga’s notion of the magic circle, tightly circumscribed spaces such as the *chashitsu* are understood to be separate from the everyday world; the strict protocol that governs behavior there nonetheless gives rise to extraordinary and unrepeatable events.⁴⁰ In such contexts, miniaturization concentrates the magical qualities of objects. By making them “manageable [and] accessible to handling,” as Rolf A. Stein writes of East Asian miniature gardens, “magical instruments share the nature of the work of art; the work of art shares that of a toy.”⁴¹

Stein’s formulation encapsulates a nexus of qualities that can also be attributed to Nintendo’s systems. From the Game & Watch (see Key 1–4) to the Wii U (2012), portability, scale, instrumentality, and illusions of magic wrought by the manipulation of technology have been integral to Nintendo’s playful enterprises. The company’s attentiveness to the spatial dimensions of gameplay has repeatedly redefined the role of the screen: rather than exclusively taking place onscreen, Nintendian gameplay unfolds through, between, and beyond screens. This idea, articulated by successive generations of Nintendo’s celebrated game designers, indicates how the screen need not operate as a cinematic or televisual fixture, but can serve simultaneously as an interface, a reflective plane, and a barrier.⁴² In different configurations, the screens of the handheld DS and home-based Wii U systems are multiple, portable, foldable (in the case of the DS), touchable, and usable as a surface for writing, drawing, and painting. In all these regards, they invoke *byōbu* (Japanese folding screens), such as those painted by (or under the influence of) Edo-period artist Jakuchū Itō (Figure 81): as loci of both revelation and concealment, they help define a space analogous to the *chashitsu* in which formally defined yet delightfully unexpected encounters may take place.⁴³

In audible terms, the paradigm of high-fidelity musical reproduction associated with the home theater or the compressed formats and mobile listening practices circulating around Sony’s Walkman and Apple’s iPod are less relevant to contemporary ludomusical praxis than the notion that the Nintendian gaming device is itself akin to an instrument such as the harmonica or melodica, both of which were widely disseminated via postwar Japanese music education programs.⁴⁴ Like the



Figure 81. Ōkuchū Itō (1716–1800), *Birds, Animals, and Flowering Plants in Imaginary Scene*, one of two six-panel folding screens (Etsuko and Joe Price Collection). Photograph © The Etsuko and Joe Price Collection.

harmonica, the Game Boy offers a distinctive timbre, located mainly in the upper portion of the audible frequency spectrum, that has been modified, extended, and repurposed by dedicated users to perform musical feats that far exceed its capacities as defined in its original design specification; like the melodica, the 3DS system (2011) affords digital, gestural, and pneumatic input and can be played in different orientations.⁴⁵ Nintendo's controllers and handheld machines are not merely representational systems, computers, prosthetic extensions of the body, modes of communication, or vehicles of fantasy (although they are all those things). As technological nodes in historico-cultural networks, they are loci of instrumental performance: through them, music informs the playing of games just as games enable the playing of music.⁴⁶

Examples of this duplex configuration are liberally strewn over Nintendo's output. Across a broad array of genres and titles, the playfulness of the company's games is often to be found where toys, instruments, music, and motion intersect. Within the mythos of *The Legend of Zelda* series, instruments such as the eponymous Ocarina of Time from the Nintendo 64 game (the playing of which is illustrated in Figure 82) perform supernatural functions such as warping through time and space, communing with the natural world, unlocking sealed gateways, and healing physical and psychic trauma.⁴⁷ The Ocarina of Time can be placed in an organological context provided by the eponymous instrument from Mozart and Schikaneder's *Die Zauberflöte*, which similarly acts as charm and summons as well as an agent of metamorphosis and protection.⁴⁸ While the magical capacities of ocarina and flute might be traced back to Athena's enchantment of the pipes picked up by the ill-fated Marsyas, in both cases pneumatic force is tempered by Apollonian discipline. In Nintendo's game, the ocarina's music is instrumental insofar as it is composed of discretely pitched elements that enable the player to accomplish gameplay



Figure 82. Link learning “Epona’s Song” in *The Legend of Zelda: Ocarina of Time* (Nintendo, 1998).



Figure 83. Nintendo 64 controller (Nintendo, 1996). The Ocarina of Time’s five principal pitches are played using the yellow and blue buttons and modulated using the central analog stick. Photograph by Evan Amos.

objectives on behalf of the protagonist Link via digital permutations remembered and recreated via the manipulation of a five-bit serial interface.⁴⁹

The performance of memorized sequences that trigger sonic responses via the pressing of the Nintendo 64 controller’s brightly colored buttons (Figure 83) invokes earlier electronic games such as Milton Bradley’s iconic *Simon* (1978). Beyond such associations, the ocarina can be played as an instrument in its own right by exploiting the range of chorded possibilities charted by Baudot when devising his



Figure 84. Screenshot from *Wii Music*'s tutorial (Nintendo, 2008).

own five-bit interface: beyond the five notes required for gameplay purposes, the player can produce a chromatic scale by means of chorded button combinations, and can even modulate pitch and timbre via the controller's analog stick.⁵⁰ In the process, the controller is transformed into an instrument and a ludomusical toy, indexed by the correspondence not only between its colored buttons and those of *Simon*, but by Milton Bradley's personal commitment to the nineteenth-century ludic and pedagogical theories of Friedrich Fröbel, the pioneer of *Kindergarten* as educational method and environment.⁵¹

The most overtly ludomusical software title in Nintendo's catalog is *Wii Music* (2008, Figure 84), which features sixty-six instruments activated by mimetic motions and techniques that players perform via the Wii remote and *nunchuk* controllers.⁵² Miyamoto, who coproduced the software, encouraged people to think of it "as a new kind of instrument. . . that allows you to become a creator . . . and a performer of music."⁵³ After the fashion of Marx and Kurtág, Miyamoto complained that "music education for young children today begins with enjoying rhythm, but then suddenly jumps into music theory. [With *Wii Music*], I seriously want to . . . be able to change that."⁵⁴ When questioned as to whether *Wii Music*'s main mode qualified as a game given its lack of an overarching goal, quantifiable progress, and unambiguous fail states, Miyamoto freely acknowledged that it did not: it was, however, "more interesting" in that it was closer to a musical toy-box.⁵⁵ Its combinatorial improvisatory mechanics evoke dice games, and even the innumerable variations generated by Winkel's comptonium and *C.P.U. Bach*: as Nintendo's then-president Satoru Iwata put it, "instead of accurately performing actions in time with a score, [*Wii Music*'s] gameplay is about enjoying limitless possibilities—all of which are correct."⁵⁶ For

his part, Miyamoto distinguished between the formal *ludus* of games and the *paidia* evoked by toys and musical instruments, both of which are implicated in synchronic and diachronic recreation à la Bizet: Nintendo is “like a toy company where we’re making these things for people to play with. As a consumer, you want to be able to . . . have those things from your youth that you can go back to and experience again.”⁵⁷

Established as a *hanafuda* playing-card manufacturer, Nintendo made products ranging from board games to dolls’ houses for almost a century prior to the Japanese release of the Famicom in 1983. The company’s approach to technology thus emerged from its lengthy history as a toy company: concomitantly, Nintendo’s digital technologies have both displayed and been subjected to a significant degree of retrogression and miniaturization. For Agamben, the toy either “[dismembers] and [distorts] the past or [miniaturizes] the present”: toys shrink the most significant artifacts of the present day to the Lilliputian scale that they will assume in the future.⁵⁸ While Agamben was addressing traditional toys such as the dolls, spinning tops, and hobby horses rendered musical by Bizet’s *Jeux d’enfants*, the historical narratives that toys simultaneously evoke and conceal also have a bearing on the automation and mechanization integral to what Brian Sutton-Smith dubbed the “machine toy concept” and its instrumental implications.⁵⁹

Many of Nintendo’s most successful toys were created under the supervision of Gunpei Yokoi, who joined the company in 1965 and quickly established himself as a designer of uncommon ingenuity. Yokoi claimed that his ideal of play harked back to children’s games such as tag and hide-and-seek: he sought to “make old things possible with current technology.”⁶⁰ The Game & Watch systems by which Yokoi’s international reputation was forged drew on a peculiar mixture of cutting-edge and antiquated technologies, evincing a mindset that he termed *kareta gijutsu no suihei shikō* (“lateral thinking with seasoned technology”).⁶¹ According to this way of thinking, ludic success was more easily attainable via the radical repurposing of mature, inexpensive technology than by the adoption of the latest technical innovation for its own sake.⁶² For Yokoi, “making old things possible with current technology” thus entered into a chiasmic relation with the principle of “lateral thinking with seasoned technology.”

Yokoi’s technological approach to ludic design was framed by Japan’s volatile cultural and economic status in the aftermath of the Second World War. At first, individuals and corporations conspicuously relied on North American resources: while the *manga* artist and animator Osamu Tezuka pared down Walt Disney’s filmic animation techniques for television to save time and money, Nintendo adopted Disney characters to bring playing cards out of the gambling den and into the family home.⁶³ In both cases, imitative measures taken for expedient reasons had unintended and far-reaching consequences. Tezuka developed a repertoire of limited animation techniques that defined the nascent medium of *anime*, while Nintendo gained new

access to a broad demographic that would prove responsive to Yokoi's experiments in the world of toys.⁶⁴ As Nishikado's *Space Invaders* triumphantly demonstrated, the technological constraints and affordances of the digital-game medium in the late 1970s and early 1980s were well suited to two-dimensional sprites drawing on the iconography of *manga* and *anime* as well as the venerable calligraphic and painterly traditions that lay behind them.⁶⁵ At the same time, the proliferation of inexpensive digital instruments such as Casiotone keyboards reflected and sustained an approach to composition and arrangement that conjured musical virtues from technological necessity. Iwai locates the most significant archaeological evidence of the digital game not in nineteenth-century analog media, but in the manually activated technologies of the music box and the flipbook.⁶⁶ To the extent that they remediated and combined the properties of such antique and infantilized devices, digital systems such as the Game Boy became "an electronic flipbook" and a "musical instrument" via which "the touch of one's fingers" activated and registered the play of "moving images and music."⁶⁷ As mandated by the von Neumann architecture, the sound and images of Game Boy games are structured by a digital lattice: the sprites are constituted by the mosaic-like configuration of pixels on the screen, while the music is produced via the execution of pitches and rhythms encoded in an analogous manner to the pegs that stud the surface of Caus's organ barrel (Figure 3). *From the flipbook to anime, from music boxes to MIDI, and from the Game Boy to works of art, the audiovisual elements that play into contemporary manifestations of ludomusicality can be traced along paths that wind across geographical and chronological planes, departing from and converging at the digital arrays by which pixels and notes become commutable.*⁶⁸

Reflecting on the ways in which ludomusical relationships can be structured to become simultaneously audible, visible, and playable, Kōji Kondō, the celebrated composer of multiple soundtracks for games in *The Legend of Zelda* and *Super Mario Bros.* series, evoked the Game & Watch in observing that both the movements of characters and the sequencing of their music are synchronized to the CPU's clock, enabling the rhythm of soundtrack and gameplay to be precisely coordinated.⁶⁹ Kondō's music for *Super Mario Bros.* was composed after he had played the game intensively to gauge how Mario ran and jumped, entraining the character's rhythmic motions in order to create a satisfying counterpoint between music and gameplay.⁷⁰ Working on *New Super Mario Bros.* for the Nintendo DS more than two decades later, Kondō went a step further by choreographing the behavior of nonplayer characters (NPCs).⁷¹ As they dance and jump in time to the music, they directly affect gameplay mechanics, transforming rhythm into a strategic resource for players. While Mario's musical accompaniment was initially "inspired by the game's controls," in *New Super Mario Bros.* it both lengthens and closes the feedback loop between player and game by conducting the performance of the human-controlled protagonist in concert with the prescribed routines of the NPCs.⁷² At the same time, the emergent "performance" breaks the fourth wall, foregrounding a playful theatricality redolent both of *kabuki* and of the *commedia dell'arte* (as discussed in Key 4–4).⁷³

Whether figured in economic, political, cultural, technological, or aesthetic terms, constrained resources have provided ludic affordances for generations of Japanese game designers. For artistic directors and composers such as Miyamoto and Kondō, restrictions on storage capacity and processing power necessitated a reliance on tiling and looping, which helped drive the sprites, themes, and sound effects associated with *Super Mario Bros.* and *The Legend of Zelda* deep into players' intermedial networks and personal memories. These games have thereby acquired a potent affective charge that, as Woodrow Phoenix writes of Japanese toys, not only triggers "a cascade of forgotten or inaccessible memories," but can also function as a direct "link back to intense personal experience."⁷⁴ Compounded by nostalgia, the power of these neurological and affective connections can be witnessed in the Pavlovian responses that these classic games continue to elicit.⁷⁵ The iconic status attained by their configurations of pixels and notes extends beyond their specific audiovisual attributes: it hinges on their (re)creativity, on the multifarious ways in which they can be played and replayed, forming temporal loops that, like Link's ocarina, circumvent the linear passage of time. From dutiful novices to hardened ROM hackers and from completists to speedrunners, players of *Mario* and *Zelda* join the ends of the continuum stretching between *ludus* and *paidia* to form their own loops. Acknowledgment of the arbitrary and intransigent conditions laid down by the CPU can go hand in hand with a childlike or contrarian delight in reconfiguring, short-circuiting, or simply disregarding them.

5-2 ANALOGOUS DIGITALITIES

As explored in Key 2, the keyboard renders its own epistemological principles apprehensible by compiling and arraying elements to be digitally activated both serially and in parallel, enabling connections to be made that stretch beyond the immediate historical and cultural parameters framing any single instantiation. Its contiguous yet multifarious lineage thus complicates media historiography cast in the terms of discursive and technological equilibria, whether punctuated by Goethe, Hoffmann, and Turing (in Kittler's initial configuration) or ruptured by Euler, Fourier, Chladni, and Johann Wilhelm Ritter (as they are in Siegert's more recent iteration).⁷⁶ In articulating the unpredictable calculus of figured bass, the playful modularity of a Mozart sonata, the imaginary inner voice of Robert Schumann's *Humoreske*, op. 20 (1839), the nostalgic oscillations of Bizet's *Jeux d'enfants*, the wry Mozartian allusions and gamelan-like hypnosis of Francis Poulenc's Concerto for Two Pianos (1932), the automated frenzy of Conlon Nancarrow's studies for player piano (1948–92), or the ever-shortening feedback loops of Georg Friedrich Haas's *Ein Schattenspiel* (2004), the keyboard's digital properties have neither outmoded nor *been* outmoded by analog technologies, but have rather set them in ever-shifting parallax relief.⁷⁷

From Leibniz's binary poetics to the Nyquist-Shannon sampling theorem and beyond, digital claims to resolve sensory signals beyond the physiological limits

of retina and tympanum have elicited analogical skepticism; conversely, analog claims to capture the essence of reality have been tempered by digital rationalizations. Today, however, more distinctive values are attached to the nominal shortcomings than to the touted strengths of analog and digital technologies, borne out by the mediated messages of vinyl crackles and digital glitches.⁷⁸ Despite the master narratives of hegemony and resistance that seek to account for periods of reciprocal ascendancy and decline, each mode has shown itself to be capable of recursively processing the other. Digital-game soundtracks are performed by symphony orchestras and issued on limited-edition vinyl; conversely, chiptunes relentlessly digitize the analog musical archive, rivaling nineteenth-century piano transcriptions in scope and number.⁷⁹ Games such as *Guitar Hero* and *Rock Band* render this process tangible: analog master recordings are quantified to yield a digital score in the form of an automated algorithmic analysis, presented to players in the form of a piano roll that verifies their capacity to verify the checksums thereby calculated. In the production of electronic dance music, such digital latticework constitutes a field of playback that simultaneously visualizes and renders audible reiterative patterns that stud the sequencer's grid like an abstract mosaic, triggering vocals, sweeps, and other analog elements that have, in turn, been numerically synthesized or registered by way of Fourier's codification of signal processing.

*It is telling that the melographic iconology of the piano roll indexes—and is indexed by—contemporary digital technologies for recording, editing, sequencing, and playback.*⁸⁰ This goes to show that the role of the player piano cannot be assessed solely in terms of its fluctuating fortunes in the early-twentieth-century marketplace and its relative popularity as a reproductive device vis-à-vis the phonograph: neither its industrial nor its aesthetic attributes can fully account for its historical or media-archaeological importance. In this regard, Jevons's logical piano (Figure 19) stands as a timely (and untimely) reminder that the mechanical play of keys and the whimsy of combinatorial procedures were aesthetically abjured at precisely the moment when the political, economic, industrial, and military impact of such instrumental logic was at its most palpable. The significance of the digital logic displayed by the piano roll lies in its oblique relations not only to the computerized sequencer, but also to Caus's studded barrel (Figure 3), Bouchon's loom, *la musicienne* (Figures 4 and 5), Winkel's comptonium (Figure 45), Debain's antiphonel, Babbage's Analytical Engine, Baudot's telegraphic interface (Figure 8), Turing's universal machine, the IBM punched card, the MIDI protocol, Ablinger's *A Letter from Schoenberg* (Figure 34), and Perich's *Microtonal Wall* (Figure 32).⁸¹ In order to take account not only of the myriad factors that distinguish these digital phenomena from one another, but also of what their play(ing) might have in common, the methodological premises on which musicological, sociological, and technological investigation is typically based must be expanded.

The operation of all these devices depends not only on the making of binary distinctions, but also on their modulation into communicative analogies. As a means



Figure 85. Ele-Conga, Autoplayer, and paper disks (Nintendo, 1972). Photograph reproduced courtesy of Erik Voskuil (beforemario.com).

of articulating both through the systemic coupling of human and mechanical systems, the interface of the keyboard is attached to them, whether materially or conceptually. On occasion, its trace endures *sous rature*; the case of the keyboardless comphonium, for instance, circumscribes a space “within the machine where notation and fi gers become one,” in Abbate’s words.⁸² For the sake of interactivity, however, the inner workings of digital machinery are typically made macroscopically tangible via keys, buttons, or triggers that conform to the morphology of hands and fi gers, most commonly through five-bit interfaces such as Baudot’s telegraphic input device and Konami’s *beatmania* keyboard (Figure 9) as well as Harmonix Music Systems’ *Guitar Hero* controller and Nintendo’s *Ocarina of Time*.⁸³

The question of how the genealogy of such instruments might be mapped from the vantage point of Nintendo’s games, and in particular by the isomorphism of digital code and memory (whether programmed, stored, retrieved, or executed by human or machine), can be broached by way of a curious object that is at once a toy, a musical instrument, and a locus of recreative play. In 1972, Nintendo released the “Ele-Conga” (Figure 85), a “new kind of instrument from the electronic age” that constitutes an intriguing point of contact between its history as an “analog” toy company, its future as a digital-game company, and the musical technologies that connect the two.⁸⁴ Designed by Yokoi, and ostensibly inspired both by Yamaha’s popular Electone series of electronic organs and by the popularity of “Latin”-styled music in

Japan, the Ele-Conga was a battery-powered drum machine featuring five buttons that triggered the sounds of a snare drum, maracas, and hand-claps in addition to high- and low-pitched congas.⁸⁵ The Ele-Conga was a toy insofar as its membranophonic form was merely skeuomorphic; at the same time, it could also be played as a serious instrument and even connected to an external amplifier for live performance.

Accompanied by scores instructing players how to recreate the patterns of familiar dance rhythms, the Ele-Conga also featured an optional accessory known as the Autoplayer, which could be programmed to trigger such patterns by way of the hand-cranked revolution of paper disks punched with holes corresponding to the Ele-Conga's five buttons. Made available to players lacking the will or dexterity to produce complex rhythms manually, the Autoplayer evokes the gramophone in form and function; in contrast to the analog peaks and valleys of vinyl, however, the Autoplayer's paper disks sequence playback by strictly digital means. As noted in Key 1–4, the archaeology of this recreative method can be traced via technologies of musical automation associated with the disks and cylinders of music boxes as well as church, fairground, and barrel organs.⁸⁶ As a device to be attached to a musical instrument in order to play it automatically via punched paper, moreover, the Autoplayer itself replicates the functionality of Debain's antiphonel. Along with its paper software in the formats of scores and disks, the hardware of the Ele-Conga and Autoplayer thus simulates time-honored mechanical means of programming, performing, and recreating musical data.⁸⁷

In contradistinction to the spiral of the gramophone record, the rotations of music-box cylinders and the Autoplayer's disks can also create loops of indefinite length: digital information stored in such a format can be set in perpetual mechanical and musical motion, as was the case with Caus's automated staging of *Apollo vs. Pan* (Figure 12).⁸⁸ Kircher published an analogous design for a hydromechanical organ, modeled on the sixteenth-century instrument at the Villa d'Este in Tivoli, which also demonstrates how digital data could choreograph musical performance and movement (Figure 86).⁸⁹ The blacksmiths on the left constitute a tribute to Pythagoras, who legendarily stumbled upon the principles of tuning while listening to the relative pitches of hammers ringing out from a forge. As it revolves, the studded barrel of Kircher's organ programs the blacksmiths to hammer out a looping triadic pattern. In analogously digital terms, Miyamoto and Yokoi's staging of an agonistic confrontation between Jumpman (later to be renamed Mario) and the eponymous gorilla in *Donkey Kong* (1981, the heavily adapted Game & Watch port of which is illustrated in Figure 7) also involved barrels, hammers, ostinati, and bodies in repetitive motion: as Lerner points out, Jumpman's acquisition of a hammer triggers a Kircherian triadic pattern of sound.⁹⁰

A morphological relationship is also perceptible between Kircher's organ and the music creation mode in Nintendo's *WarioWare D.I.Y.* for the DS (Figure 87). As well as featuring a keyboard and animated humanoids, *WarioWare D.I.Y.* allows the player to tag a virtual barrel (which performs a complete revolution

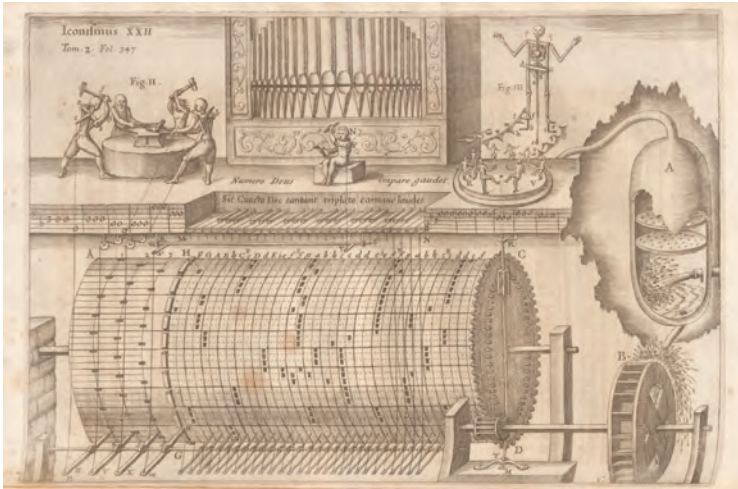


Figure 86. Kircher, *Musurgia universalis*, 2:347.

Figure 87. Screenshot from *WarioWare D.I.Y.*'s music creation mode (Nintendo, 2009–10).

every eight measures) with note markers, just as Yokoi had provided purchasers of the Ele-Conga's Autoplayer with the "seasoned technology" of blank paper disks (also capable of storing eight measures of data) and a hole punch.⁹¹

Unlike the Ele-Conga and *WarioWare D.I.Y.*, Kircher's organ was far from a vehicle of light-hearted play: the macabre figure of the skeleton, serving as a memento mori, warns of a deadly serious theological agenda.⁹² As with Kircher's other spectacular depictions, the organ was intended to arouse awe, fear, and piety rather than frivolous curiosity.⁹³ That notwithstanding, juxtaposing it with *Donkey Kong* and the Ele-Conga places all three in ludomusical and technological relief, revealing that the foundational attributes of digital games are recursively bound up with how sound has been conceived, captured, stored, organized, transmitted, recreated, and transduced by mechanical means.

As explored in Keys 1 and 2, the digital epistemology underpinning the sounding rotation of Caus's and Kircher's barrels and Yokoi's Autoplayer has ramified throughout the realms of material and visual as well as musical culture. It is closely associated with the patterns of industrialized automation that transformed Europe and North America over the course of the long nineteenth century, particularly insofar as they facilitated the production of textiles and the processing of information as well as the commodification of music and the manufacture of the self.⁹⁴ Yet while these functions were harnessed for utilitarian purposes, they could also play out as ludic, aesthetic, or autotelic phenomena that, like the synthetic fabrics that bear Jacquard's name, are intricately arbitrary in design and effect. The ambiguity of such (in)consequence reflects the straight-faced frivolity of digital computation, its Janus-like capacity to under- and overdetermine the fabric of events and their impact on human fortunes. From Babbage's Analytical Engine (conceived under Jacquard's influence in nineteenth-century London) via IBM's electric accounting machines to the optical media and hard-disk platters of PCs, generations of computing devices have been designed to process data stored on punched cards and their discoid successors.⁹⁵ The mosaic-like array of information on the cards that program a Jacquard loom can thus be seen as a "prophetic relic" not only of Herman Hollerith's tabulating machine and the player-piano music of Hans Haass and Nancarrow, but also of the grid of pixels that configures the sprite designs of raster-based digital games such as *Space Invaders* and *Super Mario Bros.*⁹⁶

Such pixelated representations can be apprehended as both miniaturizations and magnifications, both of which render them toylike. In Agamben's terms, they materialize in shrunken form the potent historicity of the objects—whether real or imaginary—that they represent, filtering them through a symbolic grid that makes them amenable to playful manipulation.⁹⁷ From the computer's perspective, however, they perform a gross enlargement of the invisible and inaudible protocols by which strings of data are processed as code and scattered across memory loca-

tions.⁹⁸ As we saw in Keys 1–5 and 3–5, the digital game flattens history by enabling the copresence of chronologically disparate phenomena via the subjunctive moods of *mimicry* and simulation. But while such ludic foreshortening accelerates, compresses, and distorts the passage of time as registered by human perception, it involves a drastic slowing down of the ultra-high frequencies at which the computer operates.

The infantilization of digital technologies of ludomusical recreation can thus be attributed to factors within and beyond the stigma attached to toys and games. On the one hand, the rapid ontogeny of late-twentieth-century developments in digital-game audio technologies has been mapped onto the millennial phylogeny of Western music history by way of narratives leading from “primitive” monophonic beginnings to increasingly “sophisticated” and “fl rid” polyphony.⁹⁹ On the other, the protocols by which the computer makes data available for audible processing and visual presentation via digital performance take the form of patronizing concessions to our sensorial and motoric limitations: to the computer, pixels and keys are as juvenile as Duplo blocks or the Ele-Conga might seem to us.¹⁰⁰ They are nonetheless indispensable if we are to take advantage of the machine-shaped opportunities digital media afford to “enter into the musical process, to intervene in its playback, to participate in . . . creation,” as Eric W. Rothenbuhler and John Durham Peters put it.¹⁰¹

From the experiments of László Moholy-Nagy and Hans Heinz Stuckenschmidt in the 1920s to the virtuosic manipulation of records by hip-hop DJs later in the century, analogous ludomusical possibilities have been created and exploited in relation to phonographic media.¹⁰² In the interests of freeing phonography from its reproductive functions, however, Moholy-Nagy felt the need to submit its oscillographic traces of the real to the symbolic order of a “groove-script alphabet,” despite the obstinate fact that such order could only be imposed by way of Fourier’s computationally cost-prohibitive processing of its inscrutable signals.¹⁰³ In a similar vein, as Cosima Rainer observes, the contemporaneous visual artists Viking Eggeling and Hans Richter sought the basis of a new “combinatorial language of graphemes” whose rules would underpin what Eggeling evocatively dubbed a *Generalbass der Malerei*.¹⁰⁴

In 1930, their dreams were realized by Rudolf Pfenninger, who devised a technique of generating any sound via optical means: after drawing the desired waveform on a paper strip, he photographed it in order to incorporate it into an optical film soundtrack.¹⁰⁵ As Thomas Y. Levin notes, Pfenninger’s curves comprised “discrete units,” which is to say “semiotic entities that can be combined to produce sounds in a . . . thoroughly technical and rule-governed manner.”¹⁰⁶ Inscriptions of such sounds were not forgeries of phonographic signatures, but synthetic simulacra whose plotting of Fourier’s equations “destroyed the logic of acoustic indexicality.”¹⁰⁷ As such, and despite their handmade qualities, they

exhibited the symbolic logic according to which the computer would translate between sounds and images that need never have existed elsewhere. Once again, the interface of the keyboard formed a digital point of contact between the two: the *New York Times* reported Pfenninger's intention to construct "a contrivance resembling a typewriter which, instead of letters, will set together sign [*sic*] waves in succession."¹⁰⁸

Tellingly, it was at precisely this juncture that doubts concerning the maturity and seriousness of Pfenninger's achievement entered the picture. Critics questioned the "primitive," "strangely unreal" qualities of Pfenninger's "mechanical" . . . carousel music" in terms that prefigure the common critique of digital games as "trivial and cartoonish," as Lerner puts it.¹⁰⁹ In their remediation of "classical" musical materials via the synthetically generated monotony of simple waveforms, the sounding shapes of Pfenninger's films such as *Pitsch und Patsch* (1932) and digital games such as Amstar's *Phoenix* (1980) converge in ways that reflect long-standing tensions between *Kling* and *Klang*, play and work, toys and aesthetic objects, commerce and art, even the mainstream and the avant-garde.¹¹⁰ Like the sounds generated by the code of Adorno's barrel organ, which processed and recycled all "unclaimed musical goods," the music of *Pitsch und Patsch* and *Phoenix* obtrudes from its immediate contexts by virtue of the contrivance of an audible and visible world from technological means that depend on fabricated simulation rather than fidelity and mimesis.¹¹¹ Both sound at once atavistic and futuristic, both older and younger than their vintages indicate.

Under the economic, cultural, and ludic conditions of postwar Japan, the qualities shared by Pfenninger's work and its media-genealogical relations resonated in unexpected ways. While one might posit tenuous historical connections between Kircher (a prominent member of the Society of Jesus), the music boxes brought to Japan by Jesuit missionaries in 1549, the importation of German-made pianos in the 1880s and their subsequent mass production under the corporate direction of Torakusu Yamaha, the global dissemination of musical, cinematic, and computational technologies throughout the twentieth century, and the aesthetics of ludomusical play espoused by Yokoi, Miyamoto, and Kondō, such links need not take the form of unidirectional vectors of transmission from Europe and North America to East Asia.¹¹² On the contrary, the lattice formed by this intersection of cultural and technological vectors can be analyzed as a digital *dispositif* that, as Hiroki Azuma has written of *otaku*, operates as a database of elements assembled from both within and beyond Japan.¹¹³ When these elements have been arrayed by Nintendo's developers into ludic programs, they have sustained diverse yet distinctive forms of playful engagement. Constituted and activated digitally, they nonetheless foster analogical play that crosses medial and geographical boundaries as it shuttles across the ludomusical interface to relay stimulus and response between human and machine.

5-3 THE LUDOMUSICAL EMERGENCE OF TOSHIO IWAI

As a digital-game player and media artist who came of age in the 1980s, Toshio Iwai quickly familiarized himself not only with the ludic systems of *Super Mario Bros.*, but also with its creative possibilities. He approached the game in a manner that responded obliquely to Kondō's methods of choreographing music and action: "I started playing around . . . , producing sounds by making Mario jump, which made me feel like I was playing instruments while playing the game."¹⁴ Iwai had a similar quasi-artistic experience "shooting along to the background music" of Namco's *Xevious*, released as an arcade game in 1983 and ported to the Famicom the following year.¹⁵ The game features invulnerable spinning tiles known as *bacura*, which emit a high-pitched metallic sound when struck by the player's blaster. This sound was adopted as a musical element in the track "Xevious," produced by Haruomi Hosono (a founding member of Yellow Magic Orchestra) as part of the album *Video Game Music* (1984). In turn, Hosono's track inspired players in arcades to try to reproduce its infectious rhythms by shooting *bacura*.¹⁶ This wasteful deployment of ludic resources might be interpreted as cocky, whimsical, contrarian, or masochistic; in any case, it flies in the face of the optimal strategy derived from game-theoretical precepts since, in terms of both score and utility, it is utterly pointless.

The Wildean inutility of such ludomusical play echoes Stein's conflation of the toy with artistic creation, pointing toward an aesthetic that Iwai's media installations and software have consistently exhibited.¹⁷ The influence of *Xevious* is clearly perceptible in *Otocky* (Scitron & Art and SEDIC, 1987), an improvisatory music-themed shoot-'em-up developed by Iwai for the Famicom Disk System. In many respects, *Otocky* is structured as a traditional game that tallies the score as players navigate diverse land- and dreamscapes (including the topography of a "cubic keyboard," illustrated in Figure 88 and Video 10), evading patterned enemy attacks and encountering "bosses" in the form of notes and other musicographical symbols. Yet, as Yoshikazu Tozuka reports, nonplussed players perceived *Otocky* as "a kind of children's toy that produces sounds," a reaction that reflects the software's ambiguously ludomusical orientation.¹⁸

Otocky blurs distinctions between game, toy, *objet d'art*, and the instrumental performance of improvisation. In part, its soundtrack is procedurally generated from the player's actions: upon the depression of the A button, the game's eponymous protagonist launches a bubble-like projectile in one of the eight cardinal and ordinal directions that inflicts damage on any enemies it strikes before returning to its sender. The speed and scope of this *fort-da* motion vary according to the timbre of the musical instrument that *Otocky* is currently wielding. At the same time, the pitch of the musical tone triggered by each button press varies in accordance



Figure 88. Screenshot from *Otocky* (Scitron & Art and SEDIC, 1987).

Video 10. Gameplay from *Otocky*, Stage 10 (“Cubic Keyboard”).

Reproduced courtesy of Daniel Chaviers
([youtube.com/watch?v=s5gAddjSiyQ](https://www.youtube.com/watch?v=s5gAddjSiyQ)).

To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.33>



with the current harmonic backdrop, which modulates as the player moves through the stage. The player’s elimination of successive enemies concatenates these tones into a melodic chain, but, as with *Xevious*, the player may choose to prioritize the creation of an optimally pleasing soundtrack over the efficient pursuit of ludic goals. To allow players to focus exclusively on aesthetic matters, Iwai incorporated an unlockable “B.G.M. (background music) Mode” that removes all traces of *ludus* from the game. While *Otocky* is invulnerable to damage in this mode, he also cannot complete the stage: the obviation of risk is synonymous with the prohibition of progress.¹¹⁹

In either gameplay mode, the modular means by which *Otocky*’s soundtrack is generated are closely akin to those of eighteenth-century *Würfelspiele* and Winkel’s componium.¹²⁰ For each harmonic module, eight melodic possibilities are assigned, any one of which can be activated by the launching of *Otocky*’s projectiles. Regardless of the player’s intentions, the arbitrariness of the informational content and timing of digital input via the Famicom controller serves to inject randomness into the game’s operationally closed system, performing the same function as the roulette-like selective mechanism of the componium. While each sequence of events is contrived from a limited set of parameters, the

number of different permutations in which music can emerge from gameplay is virtually countless.

Throughout *Otocky*, however, the singularity of emergence is entwined with the analogical and recreative logic of the loop, which is operative on local and global levels ranging from individual sonic and graphical modules and a power-up item that “records” and “replays” *Otocky*’s ballistic discharges to the game’s macrostructural principles. Players must circle around each stage until they have absorbed sufficient “note energy” to initiate the “boss” battle: each time around, previously collected notes transform into enemies, making the task more challenging and testing their memory of past events. In highlighting the emergence of idiosyncratic figures from repetitive grounds, this form of replay sets sameness and difference in reciprocal relief. It also suggests how the “horizontal resequencing” typical of *Würfelspiele* can be complemented by the concept of “vertical layering,” which approaches modularity from an orthogonal angle by way of the lateral operations through which memory becomes code (and vice versa) when “turned sideways in time.”¹²¹

Once determined by the aleatoric sequencing of single measures, a minuet produced by a *Würfelspiel* can itself be treated as a textural layer to be overlaid on or intertwined with any other by way of further arbitrary permutations. In digital-game composition, vertical layering often involves devising complementary but internally coherent generic or timbral realizations of a single harmonic and metrical template that can be combined, separated, and crossfaded in response to player actions or environmental shifts.¹²² In such cases, emergence is less synonymous with the moment-to-moment determination of musical events and more implicated in the braiding of their strands over longer spans of time. Whether reckoned as a response to player input or as the outcome of internal calculations, the consequences of vertical layering play out over temporal swathes measured as linear strips, the ends of which are in turn joined into circular loops: to rephrase Gumbrecht, the music does not undo but rather recreates itself as it emerges.¹²³

In 1996–97, Hosono’s former bandmate Ryūichi Sakamoto and Iwai collaborated on *Music Plays Images X Images Play Music (MPIXIPM)*, a conspicuously chiasmic multimedia performance staged in Mito and Tokyo.¹²⁴ The program included *Ongaku no chesu* (“Musical Chess”), an apparent homage to Cage and Marcel Duchamp’s *Reunion*, although the mechanics of the game played by Iwai and Sakamoto (Figure 89) were closer to Go than to chess. In Tokyo, the playing of *Ongaku no chesu* started with the insertion of counters into a sixteen-by-sixteen “board” that doubled as a real-time step sequencer.¹²⁵ When swept by the looping sequencer, each counter was momentarily illuminated and appeared on a rotating visualization of the game board projected above the players; at the same time, it activated a key of a Yamaha Disklavier grand piano, selected according to the mapping of a Dorian modal collection programmed by Iwai. Once satisfied with the sequencer’s state of play, Sakamoto and Iwai abandoned the game board and resorted to key-

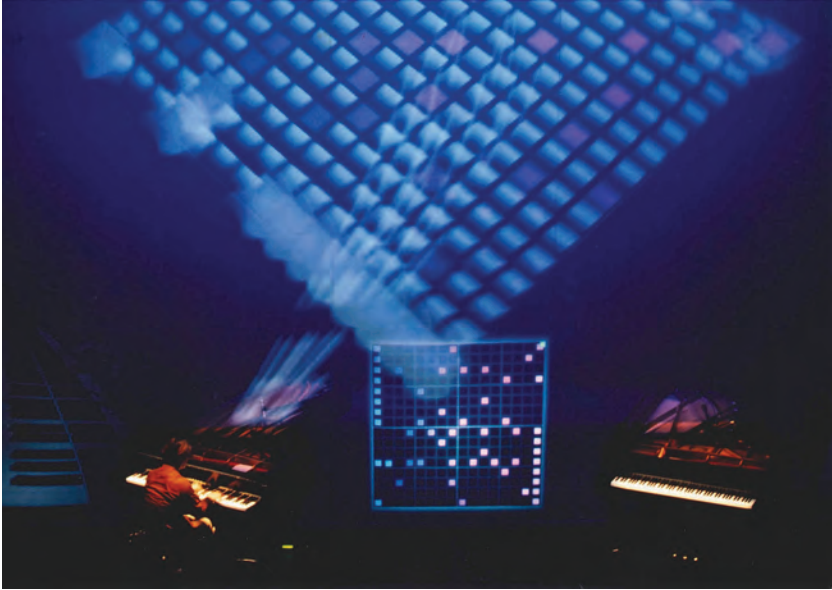


Figure 89. Toshio Iwai and Ryūichi Sakamoto, *Ongaku no chesu* at Art Tower Mito (1996). Photograph © Toshio Iwai, reproduced courtesy of Toshio Iwai and Art Tower Mito.

boards: while Sakamoto improvised at another piano, Iwai continued to manipulate the sequencer from a computer. Seeming to travel from the soundboard to the screen above, the notes played by Sakamoto triggered bursts of light redolent of shoot-'em-up projectiles such as those launched by Otocky, revealing the ludic iconology underpinning Iwai's audiovisual counterpoint as well as the commutative relation of sound and image promised by the event's palindromic title.¹²⁶

Like the pegs on Caus's barrel and the holes in the Ele-Conga Autoplayer's paper disks, Iwai's and Sakamoto's counters were processed as both pitch and rhythm, code and memory. Their quantized convertibility was represented not only by the metronomic digitality of the sonic results, but also by the analogical looping of the sequencer and the cyclical rotations of its Jacquard-like image projected above the stage. *Ongaku no chesu* thus enacted a digital analogy that complements the high-resolution grid of Perich's *Microtonal Wall* (Figure 32). Whereas Perich's installation proposes and challenges perceptual boundaries between the analog and the digital as they emerge via shifting spatial relationships between the wall and its listeners, the magnified pixelation of Iwai's sequencer reveals how discrete phenomena can become continuous when constantly (re)played via the tethering, twisting, and tangling of temporal loops.¹²⁷

These mutable qualities are also on display in prior and subsequent projects developed by Iwai for Nintendo's hardware. The best known of these is



Figure 90. “Star Fly” from *Sound Factory*, prototype of *Sound Fantasy* (Nintendo, 1993–94).

Video 11. Gameplay from “Star Fly” (*Sound Factory*).

To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.34>



Electroplankton for the Nintendo DS (2005), a launch title for the device that has been described both as “touchable media art” and as a “set of ten small musical toys.”¹²⁸ *Electroplankton* makes no attempt to keep score: instead, it presents the player with audiovisual representations of biological and physical phenomena that invite and respond to input in the form of touching, scribbling, drawing, blowing, speaking, and singing. When designing the software, Iwai drew on his media installations *Music Insects* (1992) and *Composition on the Table* (1998–99) as well as the experience of his ludomusical toying with *Super Mario Bros.*, *Xevious*, and *Otocky*.¹²⁹

Both *Electroplankton* and *Ongaku no chesu* also echo elements found in *Sound Fantasy* (1994), a project for the Super Famicom (known in the West as the Super Nintendo Entertainment System) that Iwai designed under Yokoi’s supervision.¹³⁰ In “Star Fly” (Figure 90 and Video 11), one of *Sound Fantasy*’s four modes, players use a mouse to plot constellations of stars against the invisible backdrop of a step sequencer that sonically activates them as it repeatedly scans the sky. *In this format, discrete audible and visible phenomena become observable and manipulable in direct relation to one another.*¹³¹ As in C.P.E. Bach’s *Versuch* (Figure 21), Iwai provided a skeletal backdrop against which the player’s sonic fantasy could take visible shape. Unlike Bach’s cross-domain mapping of notes, numbers, and letters via the clavichord’s digital analogicity, however, Iwai’s process of emergent creation and automated recreation are at once performed and indexed via a grid-

ded game board that, like that of *Ongaku no chesu*, figures a pixel and a note as one and the same thing.

His credentials as a media artist notwithstanding, Iwai has hewn closer to Yokoi's toy-like aesthetic than to the art world proper: his productions are characterized by the extent to which they not only make elements of compositional design, improvisation, performance, and recreation available to their players, but also map musical attributes onto Caillois's ludic modes.¹³² On being awarded a prize by the Multimedia Content Association of Japan, Iwai revealed the wistful desire, akin to that behind the pianistic inflections of Bizet's *Jeux d'enfants*, that motivated him: "I've been longing for the feeling of my childhood in the digital world."¹³³ Iwai's pursuit of *paidia* via digital channels was matched by Yokoi's commitment to recreating the pleasures of childhood through the misappropriation of "serious" electronics, thereby "making old things possible with current technology." Whether framed as toys, games, or art, the Nintendian creations of Yokoi and Iwai share the nostalgic orientation of Agamben's diachronic axis. Beyond that, their morphological materials disclose the media-genealogical heritage underpinning the ludomusical experiences, both digital and analogical, that emerge from and are (re)created through the process of play(back).

5-4 HIGH SCORES: NODAME CANTABILE

Reflecting both globalized and localized aspects of conservatory culture, *Nodame Cantabile* is an anime, live-action TV drama, and digital-game franchise based on Tomoko Ninomiya's popular *manga* that centers on the relationship—at once musical, dialectical, and romantic—between two students at the fictional Momogaoka College of Music.¹³⁴ The arrogant Shin'ichi Chiaki is an aspiring conductor who insists on impeccable standards of performance as legislated by the letter of the score; conversely, the whimsical Megumi Noda, known as Nodame, plays by ear and relies on intuition to guide her. Assigned Mozart's Sonata for Two Keyboards by their teacher Hajime Tanioka, each student initially struggles to come to terms with the other's approach: as a strict proponent of *ludus*, the overbearing Chiaki is frustrated by Nodame's departures from the score, whether deliberate or inadvertent. Ultimately, however, he is charmed and won over by her *paidia*, typified by the liberties she takes with what Kinderman describes as the "cute winks" that punctuate the first movement's second theme in the anime adaptation of the episode (illustrated in Figure 91).¹³⁵ Elevating each other to new musical heights as they perform the piece for Tanioka on a pair of Yamaha pianos, the two share an epiphanic moment that foreshadows the blossoming of their relationship.¹³⁶

Gendered asymmetry lurks behind the dialectical resolution enacted by the performance of Chiaki and Nodame. The authority assumed by Chiaki and the



Figure 91. Chiaki and Nodame perform the first movement of Mozart's Sonata for Two Keyboards in D, K. 448/375a, in the first episode of the *anime* adaptation of *Nodame Cantabile* (Fuji TV, 2007).

submissiveness of Nodame, whom he casts in the role of his pupil, recapitulate the dynamics that presumably obtained between Mozart and his own pupils Auernhammer and Ployer.¹³⁷ Staged by the sonata, the encounter between Chiaki and Nodame proceeds to synthesize a set of binary oppositions that incorporates and extends beyond the former's *ludus* and the latter's *paidia*: while the transformative freedom of her playing arises in part from the strict constraints he imposes, Chiaki's obsession with discipline and technique ultimately gives way to Nodame's playful expressivity in a manner akin to the shifting dynamics between Figaro and Susanna in the opening *duettino* of *Le nozze di Figaro*.¹³⁸

The presentation of these attributes stays relatively constant throughout the episode's remediations via *manga*, *anime*, or live-action TV. When reformatted as a digital game for Nintendo's Wii, however, the performance of Mozart's sonata reconfigures these musical qualities. In *Nodame Cantabile: Dream Orchestra*, the player simulates Chiaki and Nodame by mimicking their pianistic gestures with the Wii remote and *nunchuk* controllers, both of which register motion via gyroscopic sensors. Since the game's mechanics adhere to the norms of the rhythm-action genre established by games such as *beatmania*, *Taiko no Tatsujin*, and *Guitar Hero*, however, players' performances are quantified solely according to the accuracy with which they time their motions with the passage of stylized notes and symbols that stream across the screen (Figure 92 and Video 12).¹³⁹ Consistent demonstration of "excellent" or "acceptable" timing is rewarded by a high score and acclaimed by the in-game audience; "bad" timing is punished by the severing of the player's "combo" streak, the temporary detuning of the piano,



Figure 92. Gameplay featuring Mozart's Sonata for Two Keyboards in D, i, mm. 2–3, in *Nodame Cantabile: Dream Orchestra* (Bandai Namco, 2007).

Video 12. Gameplay from *Nodame Cantabile: Dream Orchestra*, featuring the first movement of Mozart's Sonata for Two Keyboards in D.

To watch this video, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.5255/luminos.16.3>



and even the abrupt curtailment of the performance. According to these metrics, Chiaki's uncompromising absolutism trumps Nodame's playful disregard for the rules: obedience to the score and precise execution win out over less conventional approaches to the matter of musical recreation.

While irony abounds in the game's mechanical suppression of Nodame's impetuosity, its nesting of digital and analog elements resists dichotomous explication. On the one hand, and after the fashion of *la musicienne*, *Dream Orchestra* purveys Nodame's lovable idiosyncrasies as an automatable commodity, a narrative of selfhood co-opted by the very technological and institutional forces it purports to resist.¹⁴⁰ On the other, the game's lighthearted *mimicry* simultaneously widens and seeks to bridge the distance that separates "real" musical performance from its ludic recreation via recursive strategies and techniques. *Dream Orchestra* enables the "live" recreation of a preexistent recording of Mozart's sonata via digital interfaces that index imaginary instruments, but it simultaneously remediates characters, gestures, and even affective dispositions from Nodame's parallel

representations on page and screen. Beyond the quantification of the score, the *ludus* of the game's digital logic is supplemented by the *paidia* of the analogical relations it proposes and admits.

Departing from veristic orthodoxy by virtually caricaturing the complex nuances of musical performance, the game's unabashed embrace of pretense suggests multiple relations between Nodame at her keyboard and the player wielding a Wii remote. As Miller and Kaneda note from ethnographic perspectives, play does not only take place within digital game-worlds, but also unfolds between games and their players.¹⁴¹ At the same time, as Graeme Kirkpatrick points out, an acknowledgment of this play-space often entails a suspension of the "willing suspension of disbelief" typically induced by theater and film.¹⁴² This second-order awareness of the *mimicry* of *mimicry* stymies interpretive strategies that insist on mapping stimulus directly onto response and thereby "reading" games by assigning meaning and value to their iconic and sonic significations.¹⁴³ Relieved of the responsibility to reproduce every note, the player is free to emulate Nodame by playing with (as well as within) the rules governing the ritual of musical performance. In so doing, she might paradoxically come closer to the playful aspects that suffuse the Sonata for Two Keyboards and its ludomusical design than an acoustic performance that faithfully observes the score *com'è scritto*.

The sense in which the keyboard-based mechanics and iconology of ludomusical gameplay exhibit a recreative logic that loops beyond phonographic reproduction is shared by Iwai and Alex Rigopoulos, whose development studio Harmonix Music Systems produced *Guitar Hero* and *Rock Band*. While Iwai's audiovisual technologies aim "to restore what has only recently been discarded" from musical experience owing to the blind disembodiment of the phonograph and its reproductive successors, Rigopoulos explicitly links the piano-roll notation of rhythm-action games to nineteenth-century keyboard practice: "When there were no record players, [there were] people in the house who knew how to render sheet music into music on their pianos. I see what we are doing now as a massive historical throwback."¹⁴⁴ Iwai's hardware and software have been oriented toward experimentation and real-time generation, whereas *Guitar Hero* and its successors have focused more on the notation-driven reenactment of preexistent recordings. Such differences of emphasis notwithstanding, the apprehension of all such phenomena under the performative rubric of recreation cuts across boundaries that, by strictly distinguishing between originary creative acts and their mechanical reproductions, accord ontological, legal, and aesthetic primacy to the former.¹⁴⁵ Whether figured in the technical terms of high-fidelity reproduction, the rhetoric of historically informed practice, or Walter Benjamin's auratic register, fantasies of immediacy can themselves be understood to reproduce artifacts of mediation.¹⁴⁶

Although the phonograph made storage and retrieval both audible and tangible, as discussed in Key 5–2, it denied human access to—and thus both mystified and fetishized—its technical means of transduction.¹⁴⁷ *Recreative phenomena render transmissive protocols available for observation and intervention via interfaces that explicitly distribute operative responsibility among human and mechanical agents within ludomusical systems.*¹⁴⁸ Describing recreation in these terms circumvents questions of whether such systems are interactive or passive, whether a given action is intentionally willed or unconsciously automated, and whether it is planned in advance or carried out spontaneously. Beyond its motivations and consequences, the pivotal significance of such an action resides in the fact that its very performance—whether figured as the depressing of a key or the flipping of a bit—can be processed by the human-mechanical system and thereby affect the course of its future operations.¹⁴⁹

Decades before the advent of digital signal processing, companies such as Welte-Mignon and Ampico took advantage of this difference-making potential when plotting rolls along the outlines sketched in the eighteenth century by Euler, Sulzer, and others.¹⁵⁰ Via the precise quantization and comprehensive editorial manipulation of spatial and temporal parameters before, during, and after the recorded event, Ampico claimed to cross the uncanny valley, capturing “the soul of piano playing” and “revealing”—rather than simulating or masking—the “idiosyncrasies of artists.”¹⁵¹ Marketing claims aside, a sense of possibility that the state of play might be (or might have been) otherwise distinguishes the ludic contingency of recreation from the fatality of reproduction. Recreation performs and is performed by the activation rather than the tracing of memory: its stored elements are summoned and processed as code, whether represented as pegs, notes, or holes.¹⁵² While the rules governing how such processes play out might be hard-coded, the manner of their representation and the scope of the motion they afford and constrain can vary widely, even when conceived within the same topological boundaries. Via both *ludus* and *paidia*, recreative dynamics cast reciprocal and complementary roles for humans and machines, mediated via the interfaces that couple them.

In Key 4–4, *Super Mario Bros.* for Nintendo’s Famicom and its neoclassical sequel for the Wii were invoked to draw kinesthetic parallels with the digital playing of Mozart’s keyboard concertos: both present scenarios in which the protagonist must negotiate technical challenges with dexterous flair against a backdrop designed to make navigation arduous but exhilarating. The notes of Mozart’s score and the tiles that form the landscape of the Mushroom Kingdom are loosely analogous insofar as they both provide jumping-off points for the player to demonstrate grace, imagination, and virtuosity. Even though the stingers and effects in Kondō’s soundtrack for these games are carefully integrated into their harmonic, rhythmic, and kinetic contexts and his music was composed with their graphics

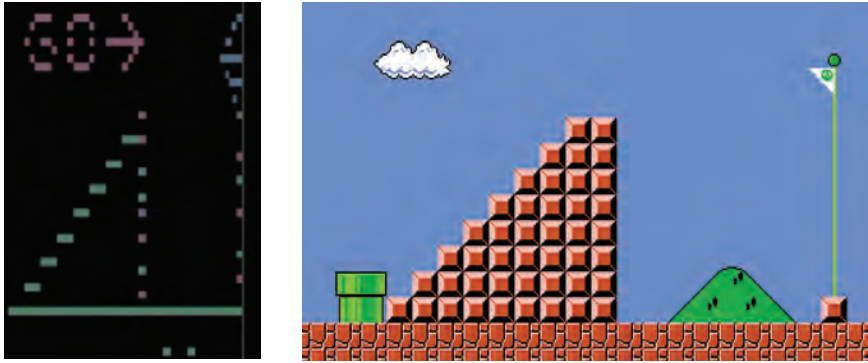


Figure 93. “Staircase” and “flagpole” from conclusion of Yōsuke Torii’s “Chōnōshuku Mario medorē” (2007). Image reproduced courtesy of Yōsuke Torii (Jinjor).

Video 13. Torii, “Chōnōshuku Mario medorē” (nicovideo.jp/watch/sm1430475).
Reproduced courtesy of Yōsuke Torii (Jinjor).

To watch this video, scan the QR code above with your mobile device or visit
DOI: <http://doi.org/10.525/luminos.16.36>



Figure 94. Staircase and flagpole from World 1-1 of *Super Mario Bros.* (Nintendo, 1985). Image reproduced courtesy of Ian Albert.



Example 3. Transcription of “staircase” and “flagpole” from Figure 93 and Audio 23.

Audio 23. “Staircase” and “flagpole” from conclusion of Torii’s “Chōnōshuku Mario medorē,” illustrated in Figure 93 and transcribed in Example 3. Reproduced courtesy of Yōsuke Torii (Jinjor).

To listen to this audio, scan the QR code above with your mobile device or visit DOI: <http://doi.org/10.525/luminos.16.37>



and gameplay in mind, it is possible to place their audiovisual elements in even closer contact by subjecting them to the commutative logic of the piano roll. As illustrated by the “super star” in Figure 89, Iwai mapped iconic representations of artifacts from *Super Mario Bros.* onto the pixelated grid of *Sound Fantasy*’s step sequencer.¹⁵ Thi teen years later, Yōsuke Torii, known as Jinjor on the Japanese video-sharing website Nico Nico Douga, uploaded a medley of music from *Mario* games made using Malinowski’s Music Animation Machine, introduced in Key

4–2 (Figure 60), which visualizes MIDI data in a piano-roll format. In the course of stitching well-loved themes together after the fashion of a Lisztian operatic *rémiscence*, Torii's transcriptive medley (Video 13) presents ludomusical display in the most literal sense: the pixelated topography and iconography of the Mushroom Kingdom are made audible while its soundtrack takes analogous shape before the observer's eyes.

After the ingenious combination of various themes and sprites, the medley concludes by (re)presenting the classic flagpole jump from the end of the opening course of *Super Mario Bros.* (Figures 93 and 94, the latter of which forms the rightmost section of Figure 69). In musical terms, the staircase of blocks becomes a stack of minor thirds, while the flagpole itself articulates cadential closure by way of a cheerful C-major resolution; indeed, the procession of harmonies heard in Audio 23, illustrated in Figure 93, and transcribed in Example 3 (diminished seventh, supertonic seventh, and tonic) just so happens to reverse and invert the harmonic sequence half-heard at the puzzling outset of Beethoven's op. 31, no. 3 (Figure 73).¹⁵⁴ The automatic playback of Torii's medley nonetheless allows observers to recreate the kinesthetic experience of moving through the course's topography while listening to the music it synonymizes.¹⁵⁵

This aspect of audiovisual ludomusicality has been pursued by Julian Benson, who proposes the transcription of musical scores into the iconographical symbology of games such as *Super Mario Bros.* and *Braid* (Number None, 2008–10), thereby creating stages to be played *through* (according to the game's own logic and mechanics) as well as *back* (by way of piano-roll-like notation).¹⁵⁶ From *BIT. TRIP RUNNER* (Gaijin Games, 2010–B) and its sequel *Runner2* (2013) to *Sound Shapes* (Queasy Games, 2012–B) and from *Rayman Legends* (Ubisoft Montpellier, 2013–14) to Nintendo's *Super Mario Maker* (2015), many recent games have blended rhythm-action and platforming gameplay to varying effect (and affect): such games compel players to oscillate between entrainment and unexpected syn-copation, between going with the ludomusical flow and staying alert to the threats that sonic bodies in motion can represent.¹⁵⁷

Accordingly, the finale of Mozart's Keyboard Concerto in F, K. 459 (discussed and displayed in Key 4–3 and 4–4), can serve as more than a musical analogy of Mario's kinetic virtuosity: in *Super Mario Maker*, its melographic score can be directly converted into a landscape for Mario to navigate. The discrete quarter-note blocks in Figure 96 map directly onto the eighth notes in the right hand of Mozart's opening measures (Figure 95), while the analog curves of Mozart's slurs can be traced by Mario's graceful motion as he trampolines through the air. This goes to show that the playfulness of recreation does not reside solely in its mechanical execution and attribution, but also emerges from the (e)motions it elicits in the course of performance as well as the audiovisual terms in which it figures. As mediated by digital gameplay, recreation does not take notions of origin and causality to be

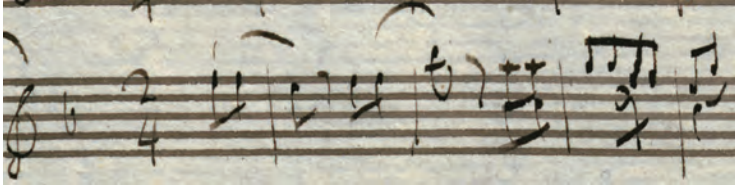


Figure 95. Mozart, autograph score of Keyboard Concerto in F, K. 459, iii, mm. 1–4 (right hand of keyboard part only). Reproduced by permission of the Staatsbibliothek zu Berlin. CC BY-NC-SA 3.0 DE.

Figure 96. “Transcription” of Figure 95 in *Super Mario Maker* (Nintendo, 2015).

self-evident; instead, it acknowledges that the presence of certain epistemological, technological, and discursive prerequisites allows for the entwining of multiple feedback loops that link elements associated with design, emergence, performance, and automated reiteration to produce the ludomusical present.

From *Otocky* and *Doom* to *Minecraft* (Mojang, 2011–16), *WarioWare D.I.Y.*, and *Super Mario Maker*, games have made the creative tools with which they were themselves designed available to players.¹³⁸ At the same time, games increasingly bear witness to their own emergence, either via procedural generative techniques (on conspicuous visual and aural display in games such as *No Man’s Sky* [Hello Games, 2016]) or by remediating games such as *Pokémon Red* in formats suitable for critical viewing—and even crowdsourced interaction, at once agonistic and collaborative—on Twitch.¹³⁹ Both phenomena index the extent to which digital games recursively configure first- and second-order techniques of participatory observation. The operational closure of their mechanical systems enables them

to couple with the innumerable digits of humans sitting in front of keyboards and screens, the chamber musicians of Flusser's imagined future.¹⁶⁰

Flusser's ambivalence toward this ludomusical prospect was grounded in the grim historical circumstances under which it was rendered conceivable: it was born of a skeptical faith in the technological forces that promised a better world to come even as they wrought destruction on an unprecedented scale.¹⁶¹ Such ambivalence is often encountered in the binary forms of utopia and apocalypse that digital games represent to their champions and detractors alike.¹⁶² As products of both myth and history, such games bear the Apollonian traces of a violent past that they all too often seek to reenact, yet their recursive attributes also endow their players with the capacity to reflect on that past, allowing it to inform the playing out of the future in ways that exceed or defy the parameters it purports to impose. Music and its histories offer a catalog of ludic resources that supplement the logic of digital play, imbuing it with affective resonances that confound Boolean logic and twist feedback loops into Möbius strips. In this regard, the sonorous and rhythmic beauty of ludomusical play is inseparable from the danger it poses, just as its momentousness hinges on its inconsequence, its value is vouchsafed by its worthlessness, and its rulership belongs to the child.

5-5 REPLAY: A CENTO

"All playing is a being-played": the chiastic and fractal logic of this final Key's recursive maneuvers reframes the capacity of play to invert relations between subjects, objects, and musical modes.¹⁶³ Music and the techniques that shape it simultaneously trace and are traced by the materials, technologies, and metaphors of play.¹⁶⁴ Any instance of play can be historically indexed and situated only once its formal properties have been identified; conversely, such properties assume significance only when embedded in the historical and cultural milieux that furnish the terms on which their legitimacy is granted, demonstrated, and questioned.¹⁶⁵ Accordingly, the question of whether play is tragic or comic, profound or whimsical, has always been a matter of perspective as well as scale.¹⁶⁶

While all media reflect the material and ideological conditions under which they have become conceivable, the case of the digital game is particularly revealing.¹⁶⁷ Games render rationality palpable: their significance derives from a vast array of visual, sonic, tactile, and affective representations that issue from the spatiotemporal modulation of digital operations.¹⁶⁸ Negotiating between the epistemological limits of Lessing's juxtapositional and progressive categories, the keyboard and its derivatives materialize and order bits of information, making them available for digital processing by both humans and machines.¹⁶⁹ Across its multifarious instantiations, the keyboard negotiates between the digital and the analog to the extent that via digital operations of selection and activation, input and output enter into an analogical relation.¹⁷⁰

*The keyboard filters the complexity of sonic phenomena and their generative mechanisms in order to grant players comprehensive control over the processing of their spatiotemporal configurations, rendering distinctions at once absolute and relative, immediately proximate and infinitely remote.*¹⁷¹

*In addition to accounting for the epistemological principles according to which keyboards bring concepts, minds, and bodies into communicative contact, however, it is necessary to attend to the cultural conditions under which their functions are analogized and mediated.*¹⁷² *As it orders and arrays musical knowledge, any given keyboard operates as an epistemological object that channels both human and non-human forces within a political ecology.*¹⁷³ *In this sense, the very literality of analogies between music and games at the keyboard outlines the complexity of their social and political ramifications as well as the ways in which they inflect concepts of musical autonomy, form, and reference that have been primarily grounded in the ontology of the musical work.*¹⁷⁴

*As a field of play, the keyboard offers access to a wide range of ludomusical experiences, whether performed as recreations of prior events, conceived as simulative praxis under a particular set of cultural conditions, or configured in the infinitely finite terms of an emergent improvisatory process.*¹⁷⁵ *Whether manifested by the strategic manipulation of notational systems or the generation of improvisatory comedy, the playfulness of eighteenth-century musical texts was coordinated by complex interactions between inscriptions, tables, calculations, mechanisms, and procedures that were typically performed at the keyboard.*¹⁷⁶ *Data-driven models of ludomusical improvisation bypassed literary modes of representation; at the same time, their combinatorial principles and hierarchical formalism were inflected by sensuous and conceptual considerations that defied symbolic reduction to and by digits alone.*¹⁷⁷ *From the dice game to the fantasia, ludomusical modes of behavior were framed by a fascination with (un)likelihood that was both economic and erotic, philosophical and trivial, whimsically capricious and grounded in quotidian reality.*¹⁷⁸ *The point of play lay in its very pointlessness, the inevitability of its undecidability, the constancy of its capriciousness, and its time-honored novelty.*¹⁷⁹

*Insofar as it made audible the purposively purposeless oscillations of the imagination, such play chimed with the Kantian aesthetics of instrumental music.*¹⁸⁰ *Apprehending improvisation as a response as well as a call, a return as well as a serve, emphasizes its dialogical performativity alongside its reiterability in a way that challenges distinctions between action and reaction, engagement and observation.*¹⁸¹ *Accordingly, any given score might be treated as a provisional sketch, as a compositional proposition or declaration of intent, as a quasi-theatrical script to be realized in performance, as a set of rules for the player to follow (or break), as a chart that maps out musical terrain to be explored, or as the tallying of a ludomusical process that serves to quantify and record prior outcomes even as it continues to precipitate new ones.*¹⁸² *A ludomusical approach to the play of performance neither reifies the*

score nor self-consciously applies information gleaned beyond its confines, but rather acknowledges how text and praxis are systemically interwoven.¹⁸³

As Hermann Abert noted in relation to the eighteenth-century “delight in playful gestures,” Mozart’s elegant forms are at once traced and elaborated by figures set in graceful motion.¹⁸⁴ Within the scope of a particular musical occasion, the joys of play emerged directly from a process of planning and design, whether it involved dashing off a scatological canon or scripting an entire concerto.¹⁸⁵ Like a Mario game, the playing of a Mozart concerto primarily involves interactive digital input: in prompting both linear and looping motions through time and space, it responds to imaginative engagement rather than hermeneutical exegesis.¹⁸⁶ Yet while Mozart’s notes on paper are readily apprehended as rules or scripts, Beethoven’s scores have been revered as unbreakable records rather than read as invitations to join the ludomusical fray.¹⁸⁷

From Beethoven’s *bagatelles* to Pinball Pianola, recreative devices and techniques form a genealogical and epistemological supplement to the dominant narrative that relates the technological mediation of sound primarily in terms of ever-increasing verisimilitude, a narrative belied over the course of the last three decades by a decisive turn away from the analogical demonstration of naturalistic fidelity and toward the digital attributes of promiscuity, economy, and mobility.¹⁸⁸ Recreative phenomena render transmissive protocols available for observation and intervention via interfaces that explicitly distribute operative responsibility among human and mechanical agents within ludomusical systems.¹⁸⁹ It is telling that the melographic iconology of the piano roll indexes—and is indexed by—contemporary digital technologies for recording, editing, sequencing, and playback.¹⁹⁰ In this format, discrete audible and visible phenomena become observable and manipulable in direct relation to one another.¹⁹¹ From the flipbook to anime, from music boxes to MIDI, and from the Game Boy to works of art, the audiovisual elements that play into contemporary manifestations of ludomusicality can be traced along paths that wind across geographical and chronological planes, departing from and converging at the digital arrays by which pixels and notes become commutable.¹⁹²

“All playing is a being-played”: the chiasmic and fractal logic of this final Key’s recursive maneuvers reframes the capacity of play to invert relations between subjects, objects, and musical modes.¹⁹³

notes

PRELUDE

1. Huizinga, *Homo Ludens*, 158; see also Key 1–0, note 1. Anglophone exceptions include Paul Schleuse’s *Singing Games in Early Modern Italy*; W. Dean Sutcliffe’s multifaceted examination of the “ingenious Jesting with Art” performed by (way of) Domenico Scarlatti’s keyboard sonatas (*The Keyboard Sonatas of Domenico Scarlatti*, esp. 73–77 and 276–319); Gretchen A. Wheelock’s exploration of wit, humor, and playfulness in Haydn’s music, the title of which directly invokes Scarlatti (*Haydn’s Ingenious Jesting with Art*, esp. 203–6); Peter Pesic’s ludic analysis of Mozart’s Keyboard Sonata in B flat, K. 570 (“The Child and the Daemon”); Edward Klorman’s *Mozart’s Music of Friends*; and Anthony Bateman’s useful overview of music at the nexus of sport and modernism (“*Ludus Tonalis*”).

2. Scherer, *Klavier-Spiele*.

3. Huizinga, *Homo Ludens*, 47.

4. Bateson, “A Theory of Play as Fantasy,” 139–43.

5. Siegert, *Cultural Techniques*, 13. On the distinction between first- and second-order techniques of participation and observation in the contexts of systems theory and cybernetics, see Luhmann, *Art as a Social System*; Key 3–1, note 25; and Key 3–5, note 274.

6. “*Alles spielen ist ein Gespielt-werden.*” Gadamer, *Wahrheit und Methode*, 112 (italics in original); translation in *Truth and Method*, 106. Analogous concepts were articulated by Michel de Montaigne, who asked, “Quand je me joue à ma chatte, qui sçait si elle passe son temps de moy plus que je ne fay d’elle?” (*Les essais*, 474); Martin Heidegger, who asserted that “it is not we who play with words; rather, the essence of language plays with us” (“What Calls for Thi king?,” 365); and Theodor W. Adorno, who performed a more straight-faced chiasmic maneuver in relation to music: “Wir verstehen nicht die Musik—sie versteht uns” (*Beethoven*, 15).

7. Riskin, “Eighteenth-Century Wetware,” 97–98.
8. *Ibid.*, 17–19.
9. On Vaucanson’s subsequent work on the automation of looms, its indebtedness to his previous automata, and its computational implications, see Riskin, “The Defecating Duck,” 625–33; and Key 1–4, notes 239–40.
10. See Foucault, *The Archaeology of Knowledge*; and Foucault, “Nietzsche, Genealogy, History.”
11. See Kittler, *Discourse Networks, 1800/Ø00*; Kittler, *Gramophone, Film, Typewriter*; and Kittler, *The Truth of the Technological World*.
12. Leichtentritt, *Analyse von Chopins Klavierwerken*, 2:109.
13. In phenomenological terms, these digital and manual parallels have been investigated in greatest detail by David Sudnow, who wrote exhaustively on jazz improvisation at the piano (*Ways of the Hand*); its relationship with typing (*Talk’s Body*); and the digital gameplay of *Breakout* (1976) at the Atari 2600 (*Pilgrim in the Microworld*). More recently, the same elements have been combined to program the ludomusical playback of the retro-techno soundtrack that emerges from Pippin Barr’s browser game *Sound System II* (2015).
14. See Cook, *Beyond the Score*, 256–73.
15. See Gooley, *The Virtuoso Liszt*; Gooley, “Saving Improvisation”; Gooley, “Schumann and Agencies of Improvisation”; Trippett, “Après une Lecture de Liszt”; and Esse, “Encountering the *Improvvisatrice* in Italian Opera,” 758–59.
16. Paying attention to the ludic and recreative implications of digital technologies, Mark J. Butler (*Playing with Something That Runs*) and Mike D’Errico (“Interface Aesthetics”) take account of their impact on the generation and performance of contemporary electronic dance music in analogous terms.
17. On this insight, see Galloway, *Gaming*, 5, where it is attributed to Kittler. See also Hagen, “The Style of Sources”; and Montfort et al., *10 PRINT CHR\$(205.5+RND(1)) : GTO 10*.
18. See Heilmann, “Digitalität als Taktilität.”
19. In the interest of clarity and consistency, Japanese names are presented in *fi st* name–surname order throughout.
20. See note 6 above; and Key 5–5, *note 163*.

KEY 1 LUDOMUSICALITY

1. The tangled nexus of ludic and musical meanings associated with the English word “play” is not peculiar to English: analogous relations can be found in languages including German, French, Dutch, Russian, Turkish, and Japanese. See Dreyfus, “Beyond the Interpretation of Music,” 272; Hofstadter and Sander, *Surfaces and Essences*, 10–13; and Huizinga, *Homo Ludens*, 28–45 and 158–64.
2. The unruly diversity of play has long inspired inventories and catalogs of board games, games of chance, sports, and wordplay: see, for example, Alfonso X’s *Libro de los juegos* (1283); Gerolamo Cardano’s *Liber de ludo alae* (ca. 1526); Innocentio Ringhieri’s *Centi giuochi liberali* (1551); Antonio Scaino da Salò’s *Trattado del giuoco della palla* (1555); and Francis Willughby’s *Book of Games* (ca. 1660–72), all cited in Willughby, *Francis Willughby’s Book of Games*, 43–45.
3. This shuttling between noun and verb echoes Christopher Small’s influential denominalization of music (*Musicking*).

4. On the ethology of play across the animal kingdom, see Burghardt, *The Genesis of Animal Play*.

5. See Prelude, note 6.

6. Vismann, "Cultural Techniques and Sovereignty," 83.

7. See, for instance, Alexander Rehding's account of Hugo Riemann's nocturnal pursuit of elusive "undertones" at the keyboard of his piano (*Hugo Riemann and the Birth of Modern Musical Thought*, 15–35) in the psychotechnical context provided by Wolfgang Scherer (*Klavier-Spiele*, 207–8).

8. From John Locke to David Hartley and beyond, the keyboard played an important role in philosophical accounts of associationism, habit formation, and the flow of unconscious actions: see Raz, "Reverberating Nerves."

9. Huizinga, *Homo Ludens*, 42.

10. Freud, *Beyond the Pleasure Principle*, 11–16.

11. *Oxford English Dictionary*, s.v. "game" and "play."

12. Adorno, *Einleitung in die Musiksoziologie*, 120; Gadamer, *Truth and Method*, 104. Adorno noted elsewhere that "all languages apply the notion of playing to music" in the context of the "mimetic aspect of [musical] reproduction." Adorno, *Towards a Theory of Musical Reproduction*, 2.

13. See Shinkle, "Corporealis Ergo Sum."

14. Cook, *Beyond the Score*, 259–60.

15. On performance as "nondiscursive" in this sense, see Taylor, *The Archive and the Repertoire*, 3–7.

16. For an illuminating summary of anthropological approaches to the nexus of play and ritual, see Seligman et al., *Ritual and Its Consequences*, 69–101.

17. Huizinga, *Homo Ludens*, 28; Lévi-Strauss, *La pensée sauvage*, 44–47.

18. See Cook, "Beyond Creativity?," 457.

19. Thomas Turino draws productive distinctions between "participatory" and "presentational" musical performance: for him, participatory music takes shape in a manner akin to "the form, rules, and practiced moves of a game." Turino, *Music as Social Life*, 59.

20. Huizinga deployed the term "magic circle" to denote an archetypal playground, "dedicated to the performance of an act apart." Huizinga, *Homo Ludens*, 10. In this context, it is telling that "the first public concert halls [in England] arose through the conversion of 'ballrooms' or 'tennis halls,'" according to Heinrich W. Schwab ("'Anyone for Tennis?'" 129).

21. See, for instance, Calleja, "Erasing the Magic Circle."

22. Castronova, *Synthetic Worlds*, 147–60.

23. Geertz, "Deep Play." See also Neitzel, "Metacommunicative Circles," which glosses Bateson's essay "A Theory of Play as Fantasy" to explore how playful behavior can be psychologically (and, by implication, sociologically and institutionally) framed via metacommunication concerning its own status as play; Seligman et al., *Ritual and Its Consequences*, 84–93; and Goffman, *Frame Analysis*, 45 and 74, in which the concepts of "keying" and "regrounding" shed light on the (dis)enchantment of magic circles.

24. Luhmann, *Art as a Social System*, 185–87: Luhmann's systems theory itself recursively depends upon the binary distinctions it observes. See also Graeber, *The Utopia of Rules*, 190–91.

25. Juul, "The Magic Circle and the Puzzle Piece," 65. Juul's eponymous objects might be reframed in the terms of Luhmann's "Operational Closure and Structural Coupling": see Key 1–3, note 185.

26. “Mit einem Wort: den Stofftrieb muß die Persönlichkeit, und den Formtrieb die Empfänglichkeit oder die Natur in seinen gehörigen Schranken halten. . . . Wir sind nunmehr zu dem Begriff einer solchen Wechselwirkung zwischen beiden Trieben geführt worden, wo die Wirksamkeit des einen die Wirksamkeit des andern zugleich begründet und begrenzt, und wo jeder einzelne für sich gerade dadurch zu seiner höchsten Verkündigung gelangt, daß der andere thätig ist.” Schiller, *Briefe über die ästhetische Erziehung des Menschen*, 50. Except where otherwise indicated, all translations are my own.

27. Katie Salen and Eric Zimmerman describe play as transformative to the extent that it no longer merely occupies “the interstices of the system, but . . . transforms the space as a whole.” Salen and Zimmerman, *Rules of Play*, 305.

28. On the centrality of play to these movements, see, for instance, Kaprow, *Essays on the Blurring of Art and Life*; Pearce, “Games as Art”; Getsy, *From Diversion to Subversion*; Lütticken, “Playtimes”; and Levin Becker, *Many Subtle Channels*. On the history, context, and implications of *cadavre exquis*, see Kochhar-Lindgren, Schneiderman, and Denlinger, *The Exquisite Corpse*.

29. See Key 2–1, note 49. Steve Mehallo’s *FLOMM! THE BATTLE For MODERN 1923* (2013–15) occupies the parallaxic aporia that can emerge between ludic form and content: under the influence of cubism, futurism, and Dada, it “recreates the struggle of Modern Art against the Tyranny of Tradition.” The latter is represented by appurtenances of bourgeois culture that must be targeted via side-scrolling-shooter mechanics that are themselves thoroughly traditional.

30. On the history of this idea, which was transmitted via Joseph Addison and Johann Georg Sulzer, among others, see Guyer, “Free Play and True Well-Being,” 353.

31. Kant, *Vorlesungen über Anthropologie*, 559–60.

32. “Das Schöne, dessen Beurtheilung eine bloß formale Zweckmäßigkeit, d. i. eine Zweckmäßigkeit ohne Zweck, zum Grunde hat, von der Vorstellung des Guten ganz unabhängig sei.” Kant, *Kritik der Urtheilskraft*, 226.

33. “Ist’s nicht traurig, daß die sich nennende einzigmögliche Philosophie dahin gehen soll, unserer Empfänglichkeit alle Begriffe, dem Geschmacksurtheil alle Urtheilsgründe, den Künsten des Schönen allen Zweck zu nehmen, und diese Künste in ein kurz- oder langweilig-äffiges Spiel . . . ? Dürfen wir uns nicht freuen, daß wir in einer Welt der Wohlordnung und Wohlgestalt leben?” Herder, *Kalligone*, 649 and 687; see also Guyer, “Free Play and True Well-Being,” 362.

34. “Denn in der Kunst haben wir es mit keinem bloß angenehmen oder nützlichen Spielwerk, sondern . . . mit einer Entfaltung der Wahrheit zu tun.” Hegel, *Vorlesungen über die Aesthetik*, 3:580. Adorno selected this quotation as an epigraph for his *Philosophy of New Music*.

35. “Der Mensch spielt nur, wo er in voller Bedeutung des Wortes Mensch ist, und er ist nur da ganz Mensch, wo er spielt.” Schiller, *Briefe über die ästhetische Erziehung des Menschen*, 57 (italics in original). On the application of Schiller’s conception of play to music, see Pesis, “The Child and the Daemon”; and Chua, “Myth,” 207. On its relevance to digital games, see Pias, “The Game Player’s Duty,” 164–65.

36. “Lothario: Alle heiligen Spiele der Kunst sind nur ferne Nachbildungen von dem unendlichen Spiele der Welt, dem ewig sich selbst bildenden Kunstwerk.” Friedrich Schlegel, “Gespräch über die Poesie,” 364: the statement appears as part of a six-way conversation.

37. τίς οὖν ὀρθότης; παίζοντά ἐστιν διαβιωτέον τινὰς δὴ παιδίας, θύοντα καὶ ἄδοντα καὶ ὀρχούμενον, ὥστε τοὺς μὲν θεοὺς ἴλεως αὐτῷ παρασκευάζειν δυνατὸν εἶναι. Plato, *Laws* 7803e.

38. Quoted and translated in Culianu, *Eros and Magic in the Renaissance*, 37–38. Ficino’s formulation was extrapolated from a remark by Socrates’s student Xenophon (*ibid.*, 231n3).

39. αἰὼν παῖς ἐστὶ παίζων. πεσσεύων παιδὸς ἢ βασιλιῆ. Heraclitus, Fragment B. 52 [DK]; translation in Kahn, *The Art and Thought of Heraclitus*, 71.

40. Schiller, *Briefe über die ästhetische Erziehung des Menschen*, 57.

41. Lütticken, “Playtimes,” 128; see also Peters, *The Philosophy of Improvisation*, 24–25.

42. Nagel, *Masking the Abject*, 74.

43. “Daß aber in allen freien Künsten dennoch etwas Zwangsmäßiges, oder, wie man es nennt, ein *Mechanismus* erforderlich sei, ohne welchen der *Geist*, der in der Kunst *frei* sein muß und allein das Werk belebt, gar keinen Körper haben und gänzlich verdunsten würde.” Kant, *Kritik der Urtheilskraft*, 304; translation in *Critique of the Power of Judgement*, 188. Kant proceeded to assert that rules, which both constitute mechanisms and must be mechanistically obeyed, form the “essential condition” of art (*Kritik der Urtheilskraft*, 310; *Critique of the Power of Judgement*, 188). On Schiller’s ambivalence toward Kant’s formulation of the laws, constraints, and boundaries that regulate the free play of the imagination, see Luhmann, *Art as a Social System*, 203–4.

44. Pestic, “The Child and the Daemon”; Diergarten, “At Times Even Homer Nods Off,” [13].

45. On Körner, see Pestic, “The Child and the Daemon,” 96–97; Michaelis, quoted and translated in Diergarten, “At Times Even Homer Nods Off,” [13].

46. Quoted and translated in Diergarten, “At Times Even Homer Nods Off,” [13].

47. On these attributes of the fantasia, see Richards, *The Free Fantasia and the Musical Picturesque*; Wheelock, “Mozart’s Fantasy, Haydn’s Caprice”; and Head, “Fantasia and Sensibility.”

48. “Ein durchaus und durchein spielendes Wesen ist [die Tonkunst], weiter nichts. . . . Je formenreicher, spielvoller ein Tonkunstwerk ist, desto allseitiger, unfehlbarer wird es dieß bewirken; um so treffender und trefflicher ist es.” Nägeli, *Vorlesungen über Musik*, 32–33; see also Scherer, *Klavier-Spiele*, 167.

49. Forming an increasingly rich and diverse stream of German scholarship, the discourse of cultural techniques departs from the premise that “there never was a document of culture that was not also one of technology,” as Winthrop-Young puts it (“Cultural Techniques,” 6). For definitions and examples of *Kulturtechniken*, see Krämer and Bredekamp, *Bild, Schrift, Zahl*; Ernst and Kittler, *Die Geburt des Vokalalphabets aus dem Geist der Poesie*; and Siegert, *Cultural Techniques*, esp. 9–17.

50. Huizinga, *Homo Ludens*, 47.

51. Macho, “Zeit und Zahl,” 179.

52. See Key 5–5, note 164.

53. Barthes, “From Work to Text,” 62–63.

1-1 ORDERS OF PLAY

54. “Antonio: Und ich würde unmassgeblich die alte Fabel vom Apollo und Marsyas vorschlagen. Sie scheint mir sehr an der Zeit zu seyn. Oder eigentlicher zu reden ist sie wohl immer an der Zeit in jeder wohl verfassten Litteratur.” Schlegel, “Gespräch der Poesie,” 385; translation in Hamilton, *Music, Madness, and the Unworking of Language*, 35.

55. Albright, *Untwisting the Serpent*, 18–21; Hamilton, *Music, Madness, and the Unworking of Language*, 35–41; Hamilton, “Torture as an Instrument of Music,” 146; Goehr, “—wie

ihn uns Meister Dürer gemalt!”; Goehr “Improvising *Impromptu*”; Leppert, “Music, Violence, and the Stakes of Listening”; Dorschel, “Music and Pain”; and Currie, *Music and the Politics of Negation*, 62–64. The contest is framed within the context of ancient Greek practice and theory in Mathiesen, *Apollo’s Lyre*, 178–82; McKinnon, “The Rejection of the Aulos in Classical Greece”; and Van Keer, “The Myth of Marsyas in Ancient Greek Art.”

56. On the critical strategy of turning anachronism to historical advantage, see Didi-Huberman, *Confronting Images*, 38–42; and Cohen, *Art in the Era of Alexander the Great*, 11.

57. The standard version of the myth is passed down by the second-century c.e. mythographers Pseudo-Apollodorus and Hyginus, translated in Smith and Trzaskoma, *Apollodorus’ Library and Hyginus’ Fabulae*, 4 and 152, respectively. See also Ovid, *Metamorphoses* 6.382–400, and *Fasti* 6.697–710; Pausanias, *Description of Greece* 2.7.9; Philostratus the Younger, *Imagines* 2; and Edzard Visser’s discussion of further sources (“Marsyas”). For my purposes here, it is neither possible nor desirable to draw a firm distinction between the myth’s origin and its later Greek and Roman reception history, on which see Feldherr, “Flaying the Other”; Maniates, “*Marsyas Agonistes*”; and Van Keer, “The Myth of Marsyas.”

58. Pliny the Elder and Nonnus both associated Marsyas with the double aulos. See Pliny, *Natural History* 7.204: *adicit . . . geminas tibias Marsyas* (“Marsyas invented the twin aulos”); and Nonnus, *Dionysiaca* 10.234: διδυμόθροον αὐλὸν Ἀθήνης (“the double-voiced aulos of Athena”).

59. On the umpires’ initial inclination toward Marsyas, see McKinnon, “The Rejection of the Aulos,” 213.

60. For the more common upside-down version, see Smith and Trzaskoma, *Apollodorus’ Library and Hyginus’ Fabulae*, 4 and 152; for the vocal version, see Diodorus Siculus, *Library of History* 3.59. Ellen Van Keer interprets the latter as a reactionary response to the growing popularity of polyphonic aulos music in the fifth century b.c.e. (“The Myth of Marsyas,” 26–27), whereas Mladen Dolar interprets the preference for Apollonian instruments over their Marsyan counterparts in Plato’s *Laws* in light of the fact that “one cannot speak words while playing the flute. . . . [Wind] instruments . . . emancipate themselves from the text, they are substitutes for the voice as the voice beyond words.” Dolar, “The Object Voice,” 19.

61. Ovid, *Metamorphoses* 6.382–400. On Marsyas as a wineskin, see Plato, *Euthydemus* 285c; as a windbag, see Nonnus, *Dionysiaca* 19.320–22; and as a drum, see Abbate, *In Search of Opera*, 87.

62. Aristides Quintilianus, *On Music* 2: 19; see also Mathiesen, *Apollo’s Lyre*, 180.

63. See, for instance, Leppert, “Music, Violence, and the Stakes of Listening.” In different ways, McKinnon, Mathiesen, and Van Keer point out how the myth’s staging of ludomusical conflict artificially simplifies the relative status of instruments in Greek religion and culture, refracting the complex dynamics of Athenian politics rather than asserting fundamental distinctions between kithara and aulos.

64. On the marked binary that elevated Apollo over the Eastern, bestial, feminine, and instrumentalized Marsyas, see Leclercq-Niveu, “Marsyas, le martyr de l’Aulos”; Mathiesen, *Apollo’s Lyre*, 160–61 and 178; and Van Keer, “The Myth of Marsyas,” 22–23. On satyrs as embodiments of all that is “other” to the civilized citizen male in classical Greek culture, see Lissarrague, “Why Satyrs Are Good to Represent”; and Lissarrague, *La cité des satyres*.

65. See, for instance, Currie, *Music and the Politics of Negation*, 63. On the statue of Marsyas, see Pliny the Elder, *Natural History* 21.8–9; Seneca the Younger, *De Beneficiis* 6.32;

and Martial, *Epigrams* 2.64. Located in the Forum Romanum, it was intended to warn of the state's retributive powers, but also served as a subversive symbol of *libertas* and free speech by way of Marsyas's association with the god Liber (Dionysus): see Wiseman, "Satyrs in Rome?"; and Fantham, "Liberty and the People in Republican Rome."

66. See Feldherr, "Flaying the Other," 78–80; and Hamilton, *Music, Madness, and the Unworking of Language*, 37.

67. On the *pankraton*, see Miller, *Arete*, 37–39; on the violent Roman reenactment of Greek myth for retribution and public entertainment, see Coleman, "Fatal Charades." Such nominally ludic spectacles were not uniquely European: on *Ollamaliztli*, the deadly Mesoamerican ballgame played as long ago as the second millennium b.c.e., see Whittington, *The Sport of Life and Death*.

68. See Miller, *Arete*, 58–59.

69. See Huizinga, *Homo Ludens*, 48; and Caillois, *Les jeux et les hommes*, 50–55 (*Man, Play and Games*, 14–17).

70. On Marsyas's agony, see Dorschel, "Music and Pain," 68–71; and Hamilton, *Music, Madness, and the Unworking of Language*, 40–41. As noted by Albright, the contest between Apollo vs. Marsyas resonated with particular force across the first half of the twentieth century, thematizing modernistic conflicts between musical and intermedial stances and practices (*Untwisting the Serpent*, 18). Vladimir Jankélévitch lists works by Fauré ("Hymne à Apollon"), Roussel (the opera *La naissance de la lyre*), and Stravinsky (the ballet *Apollon musagète*) as evidence of a Gallic penchant for the aesthetics of Apollonian ideology (*Music and the Ineffable*, 5).

71. Huizinga, *Homo Ludens*, 5 and 41.

72. Quoted and translated in Flaherty, "Mattheson and the Aesthetics of Theater," 79. In his poem "The Statue and the Bust," Robert Browning summed up the primacy and ludic amorality of the kind of play that Huizinga and Mattheson championed: "If you choose to play!—is my principle. / Let a man contend to the uttermost / For his life's set prize, be it what it will!" Browning, *Selected Poems*, 107.

73. Goehr, "'—wie ihn uns Meister Dürer gemalt!,'" 59–76; Goehr, "Improvising *Impromptu*"; Huizinga, *Homo Ludens*, 163–64.

74. Schwab, "'Anyone for Tennis?'" 135. On the ludomusical activities both documented and prompted by *cinquecento* composer Orazio Vecchi's *Le veglie di Siena*, see Schleuse, *Singing Games in Early Modern Italy*, 36–42 and 195–244: as Schleuse points out, such games are often underlaid with an erotic subtext involving "contention [that] is ultimately the competition for love" (*ibid.*, 212). Tellingly, Vecchi himself cited Aristotle in defining music as a game in his preface to *Le veglie di Siena*, in which he set out to "play with all the genres of music" (quoted and translated in *ibid.*, 241).

75. Rossini set his canzonettas to texts by Francesco Maria Piave. He clearly found the theme of gondola racing appealing: *La regata veneziana* is also the title of a duet for two sopranos and piano, published as no. 9 of his *Soirées musicales* (1835), that sets a poem by Carlo Pepoli to closely analogous effect.

76. On *L'Olimpiade* and the ways in which its Olympic ideology resonated with Courtin's, see Segrave, "Music as Sport History."

77. On the patriotic and gymnastic context of Suk's entry and its relation to works by Antonín Dvořák and Leoš Janáček, see Bateman, "*Ludus Tonalis*," 157–60.

78. Ibid.

79. Honegger, quoted and translated in *ibid.*, 153. Berwald described *Wettlauf* as an “Etüde für großes Orchester.”

80. Shostakovich’s friend Isaak Glikman testified to the composer’s deep love of soccer: “He loved it best when the game was open, honorable and chivalrous. He found intensely moving the selfless absorption [of the players]. . . . What attracted Shostakovich to football, I believe, was an idealized vision of the game.” Glikman, *Story of a Friendship*, xxviii. See also Bateman’s discussion of Martinů’s *Polička* (1925), a musical representation of the motion and hubbub of a crowd at a soccer match (“*Ludus Tonalis*,” 149–52).

81. See Yakubov, “*The Golden Age*.”

82. *Reunion* (1968) was a collaborative electro-acoustic performance that featured a ludomusical game of chess between Marcel Duchamp, a highly skilled player who took the game very seriously, and John Cage, who was not and did not. See Cross, “*Reunion: John Cage, Marcel Duchamp, Electronic Music and Chess*”; and Smith, “*Reunion: Duchamp, Cage and Ludology*.”

83. On the contrapuntal, serial, and structural dynamics of *Agon* as a ludomusical composition, see Westerhaus, “Stravinsky and the Ludic Metaphor,” 295–339. Westerhaus mentions Balanchine’s partnering of Arthur Mitchell (an African American dancer) and Diana Adams (who was white) for the *pas-de-deux* (*ibid.*, 309–10).

84. Huizinga explicitly connected the face-off between Handel and Scarlatti to the battle between Apollo and Marsyas (*Homo Ludens*, 163). Other storied clashes include those between J.S. Bach and Louis Marchand (who reputedly turned tail and fled to avoid the ignominy of defeat: see Williams, *The Life of Bach*, 72–74); Mozart and Muzio Clementi (see Komlós, “Mozart and Clementi”); Beethoven and Joseph Wölfl, Daniel Steibelt, Joseph Gelinek, and Georg Joseph Vogler (see DeNora, “The Beethoven—Wölfl Piano Duel”; Skowronek, *Beethoven the Pianist*, 65–67 and 144–45; and Rowen, “Beethoven’s Parody of Nature,” 48–49); Franz Liszt and Sigismond Thalberg (see Gooley, *The Virtuoso Liszt*, 18–77); and Sergei Rachmaninoff and Josef Lhévinne (see Wallace, *A Century of Music-Making*, 32–33). In the twentieth century, the *mano-a-mano* format of the duel was supplanted by the sequence of rounds that progressively narrow the field in today’s music competitions, the playing out of which combines sporting and ritual elements: see McCormick, “Higher, Faster, Louder.” I am grateful to Dietmar Friesenegger for sharing his perspectives on these phenomena.

85. As Goehr notes, such duels are most commonly staged today within the overtly improvisatory genres (and socioeconomic frameworks) of jazz’s “cutting contests” and hip-hop battles conducted via microphones and turntables (“*Improvising Impromptu*”: see also Katz, *Groove Music*, 153–78), both of which are closely related to the agonistic African American tradition of “the Dozens” (on which see Wald, *The Dozens*). In turn, technologically mediated musical praxis associated with hip hop and other dance-music genres informed *beatmania*’s initial billing as an “interactive DJ simulation game” as well as the *Guitar Hero* spin-off *DJ Hero* (2009–10).

86. Although Huizinga acknowledged that collaborative music-making could be playful without being agonistic, he nonetheless insisted on its “antithetical” character (*Homo Ludens*, 47).

87. Caillois had been closely associated with surrealism before distancing himself from the movement in the 1930s. In a letter to André Breton explaining his reasons for doing so, he remarked that as a child “I could never really have fun with toys; I was constantly ripping

them open or dismantling them to find out ‘what they were like inside, how they worked.’” Quoted and translated in Frank, *The Edge of Surrealism*, 85; see also Mesch, “Serious Play,” 62–63. While one might suspect that this tendency informed his taxonomy of play, it remains a flexible and powerful tool for investigating the categorical and relational characteristics of ludic activities. For a more recent taxonomy of play that redefines and supplements Caillois’s categories from a rhetorical perspective, see Sutton-Smith, *The Ambiguity of Play*.

88. Caillois, *Les jeux et les hommes*, 277–307 (*Man, Play and Games*, 145–60).

89. Caillois, *Les jeux et les hommes*, 31–44 (*Man, Play and Games*, 3–10).

90. κείνου δὲ θρίαῖ καὶ μάντιες. . . Callimachus, *Hymn 2 (to Apollo)*, line 45.

91. “Wir selber mit eisernen Händen den Würfelbecher schütteln, dass wir selber in unseren absichtlichsten Handlungen Nichts mehr thun, als das Spiel der Nothwendigkeit zu spielen.” Nietzsche, *Morgenröthe*, 125.

92. Derrida, “Différance,” 135.

93. Quoted and translated in Campe, *The Game of Probability*, 21. As Michael Long observes, the *Missa Di dadi* attributed to Josquin (1514) draws upon the profane symbology of dice and gambling, but puts them to theological work by treating them as “objects of devotional meditation.” Long, “Symbol and Ritual in Josquin’s *Missa Di Dadi*,” 21.

94. Schleuse, *Singing Games in Early Modern Italy*, 183; see also Schleuse’s description of Giovanni Croce’s *Il gioco dell’oca* (1596), which recounts the triumph of rank and virtue via the playing of a board game (*ibid.*, 186–95).

95. On *The Queen of Spades*, see Morrison, *Russian Opera and the Symbolist Movement*, 48–119. In an analogous vein, Sergei Prokofiev completed an operatic adaptation of Fyodor Dostoevsky’s novella *The Gambler* in 1929. When assembling an orchestral suite from the opera in 1931, Prokofiev claimed to have ripped up a score and “dealt” relevant pages into “hands” for each of the four main characters: see Taruskin, “*The Gambler*.” On Stravinsky’s whimsical *Jeu de cartes*, see Westerhaus, “Stravinsky and the Ludic Metaphor,” 252–94. For his part, Shostakovich started work on an operatic setting of Nikolai Gogol’s play *The Gamblers* in 1942, but never finished it.

96. I am grateful to Roberto Sierra for bringing *Votre Faust* to my attention.

97. On the “relatively lowly” prehistory of the word “mimesis,” which suggests that the high-flown Athenian practice of dramatic reenactment “once had a less important and less serious tone,” see Nagy, *Poetry as Performance*, 80–81.

98. “Guazzo: Doesn’t one who imitates play a kind of game? So says Plato in the tenth book of the *Laws*.” Comanini, *Il Figino*, 80. Turing introduced his own influential notion of the “imitation game” in “Computing Machinery and Intelligence.”

99. ἐνδόμυχος κόλπωσε τύπον μμηλὸν ἀήτης, / οἷα πάντα μέλλοντος ἀσιγήτοιο νομήος. Nonnus, *Dionysiaca* 19.321–22.

100. Huizinga remarked that “[in] all the wild imaginings of mythology, a fanciful spirit is playing on the borderline between jest and earnest.” Huizinga, *Homo Ludens*, 5.

101. Philostratus the Younger, *Imagines* 2.

102. In this light, the historical synonymy of actor and player is telling, as in Jaques’s famous metaphor in act 2, scene 7, of Shakespeare’s *As You Like It* (p. 227): “All the world’s a stage / And all the men and women merely players.”

103. Caillois, *Les jeux et les hommes*, 67; translation in *Man, Play and Games*, 23.

104. Kittler, *The Truth of the Technological World*, 20. The Nietzschean overtones of Caillois’s formulation of *ilinx* might also be construed in relation to his involvement with

Breton, Antonin Artaud, and others associated with the surrealist movement in the 1920s (on which see note 87 above).

105. McKee, “Ballroom Dances of the Late Eighteenth Century,” 176–77. On humorous and vertiginous aspects of the scherzo from Haydn to Liszt and beyond, see Russell, “Minuet, Scherzando, and Scherzo”; and Brittan, “On Microscopic Hearing.” On the capriccio, see Wheelock, “Mozart’s Fantasy, Haydn’s Caprice.”

106. Quoted and translated in Sonneck, *Beethoven*, 42.

107. The broad scope of Bizet’s *Jeux d’enfants* might be considered to furnish a musical analogy to Pieter Bruegel’s encyclopedic painting “Children’s Games” (ca. 1560) as well as to nineteenth-century manuals such as Mme. Henri Tardieu-Deneslé’s *Les jeux innocents de société*. On Bizet’s musical representation of leapfrog, see Key 5–0.

108. *awhirl* (2008), a piece by Rand Steiger that involves various types of digital signal processing at the piano, also vividly conveys the sensation of *ilinx*. I am grateful to Ryan MacEvoy McCullough for bringing *awhirl* to my attention. On the intensity and ambiguity of ludic phenomena that imbricate pleasure and pain, fear and exhilaration, see Hackett, “Passion Play.”

109. See Seligman et al., *Ritual and Its Consequences*, 82–83.

110. Caillois, *Les jeux et les hommes*, 75–90 (*Man, Play and Games*, 27–35).

111. For Émile Benveniste, conversely, the association of *ludus* with gladiatorial combat implicated it in agonistic struggle and the harsh rituals of scholastic and military entrainment (“Le jeu comme structure,” 163).

112. In the 1960s, such approaches to chess were facilitated by the various *Fluxchess* sets sold by George Maciunas and the anti-zero-sum design of Yoko Ono’s *White Chess Set* (1966), all of which were preceded by Arnold Schoenberg’s *Coalition Chess* (ca. 1920–25), an asymmetrical four-player variant of the game that compelled players to form alliances rather than—or as well as—to vanquish one another.

1B. In the preface to *Sports et divertissements*, Satie suggested that readers “turn its pages with a tolerant thumb and with a smile, for this is a work of pure whimsy. Let no one look for more.” Quoted and translated in Bateman, “*Ludus Tonalis*,” 148.

1A. For a comprehensive overview of “tennis compositions,” incorporating reflections on little-known works by Darius Milhaud, Jean Sibelius, and Ragnar Söderlind, see Schwab, “Anyone for Tennis?” The notational system that Schoenberg devised for the purpose of recording tennis games (described in *ibid.*, 136) provides further evidence of this ludomusical connection, as does the sport of tambourelli, an adaptation of badminton in which racquets are replaced with modified tambourines.

1B. On these aspects of *Jeux*, see Schwab, “Anyone for Tennis?,” 140–42; Bateman, “*Ludus Tonalis*,” 146–48; and Larín, “‘Waves’ in Debussy’s *Jeux*.”

116. On ludic elements in Xenakis’s music, see Schmidt, *Komposition und Spiel*. In a similar vein, Mauricio Kagel’s *Match für 3 Spieler* (1964) stages a duel between two cellists, umpired by a percussionist (see Schwab, “Anyone for Tennis?,” 137–38). John Zorn’s “game pieces” might also be considered in light of *Duel*, *Stratégie*, and Karlheinz Stockhausen’s *Kreuzspiel* (1951) despite their starkly contrasting idioms, aesthetics, and means of distributing ludic agency. Zorn’s pieces, conceived in the 1970s and 1980s for highly accomplished performers and improvisers, include *Cobra*, *Hockey*, *Track and Field*, *Lacrosse*, and *Xu Feng*; see Zorn, “The Game Pieces”; and Evens, *Sound Ideas*, 152–54.

17. Foucault, *The Archaeology of Knowledge*, 4; see also Key 3-1, notes 43-46; and Graeber, *The Utopia of Rules*.

118. "Reife des Mannes: das heisst den Ernst wiedergefunden haben, den man als Kind hatte, beim Spiel." Nietzsche, *Jenseits von Gut und Böse*, 91.

119. "Jener absolut freie Wille kann aber nur zwecklos gedacht werden, ungefähr nach Art des Kinderspieles oder des künstlerischen Spieltriebes." Nietzsche, *Die Philosophie im tragischen Zeitalter der Griechen*, 91; translation in *Philosophy in the Tragic Age of the Greeks*, 116.

120. "Ein Werden und Vergehen, ein Bauen und Zerstören, ohne jede moralische Zurechnung, in ewig gleicher Unschuld, hat in dieser Welt allein das Spiel des Künstlers und des Kindes. Und so, wie das Kind und der Künstler spielt, spielt das ewig lebendige Feuer, baut auf und zerstört, in Unschuld—und dieses Spiel spielt der Aeon mit sich. Sich verwandelnd in Wasser und Erde thürmt er, wie ein Kind Sandhaufen am Meere, thürmt auf und zertrümmert; von Zeit zu Zeit fängt er das Spiel von Neuem an. . . . Nicht Frevelmuth, sondern der immer neu erwachende Spieltrieb ruft andre Welten ins Leben." Nietzsche, *Die Philosophie im tragischen Zeitalter der Griechen*, 41; translation in *Philosophy in the Tragic Age of the Greeks*, 62.

121. Homer, *Iliad* 15.361-66.

122. Shakespeare, *King Lear*, act 4, scene 1 (p. 306). The fervent Shakespearean Hector Berlioz toyed with the idea of quoting these lines as an epigraph to his *Symphonie fantastique*.

123. See Key 5-5, *wte* 166.

124. "Das Kind wirft einmal das Spielzeug weg: bald aber fängt es wieder an, in unschuldiger Laune. Sobald es aber baut, knüpft fügt und formt es gesetzmäßig und nach inneren Ordnungen." Nietzsche, *Die Philosophie im tragischen Zeitalter der Griechen*, 41; translation in *Philosophy in the Tragic Age of the Greeks*, 62.

1-2 BEYOND WORK AND PLAY

125. Weber, *Die protestantische Ethik und der Geist des Kapitalismus*.

126. Brown, *The Material Unconscious*, 119; Marcuse, "On the Philosophical Foundation of the Concept of Labor in Economics," 15. For an extension of Weber's concept of rationalization to the realms of play and leisure, see Henricks, *Play Reconsidered*, 78-108.

127. On this historical process and its aesthetic ramifications, see Goehr, *The Imaginary Museum of Musical Works*; and Hunter, "'To Play as if from the Soul of the Composer.'"

128. Gooley, "Schumann and Agencies of Improvisation."

129. Quoted and translated in *ibid.*, 151 (italics in original).

130. *Ibid.*, 149; see also Levy, "Covert and Casual Values in Recent Writings about Music," 7-12. In a similar vein, Franco Moretti observes that in Goethe's *Wilhelm Meisters Wanderjahre* (1829), aesthetic beauty no longer arises from purposive purposelessness, but is programmatically derived "From the Useful by Way of the True" (quoted and translated in *The Bourgeois*, 39).

131. Goehr, "'—wie ihn uns Meister Dürer gemalt!,'" 67; see also Jackson, *Harmonious Triads*, 75-76. Daniel K. L. Chua tracks this train of thought back to Jean-Jacques Rousseau's dismissal of musical instruments as soulless "tools that merely alienate man from nature." Chua, *Absolute Music and the Construction of Meaning*, 99. These attitudes could be understood to mark a more or less conscious adoption of Platonic values concerning the

relation both of instrumental to vocal music and of professionalism to amateurism, discussed by McKinnon in light of Apollo vs. Marsyas (“The Rejection of the Aulos,” 204–14).

132. Goehr, “—wie ihn uns Meister Dürer gemalt!,” 58.

133. “Jeder von uns hat als Kind sich wohl an dem wechselnden Farben- und Formen-spiel eines Kaleidoskops ergötzt. Ein solches Kaleidoskop auf incommensurabel höherer Erscheinungsstufe ist Musik.” Hanslick, *Vom Musikalisch-Schönen*, 75; on this aspect of Hanslick’s thought, see Burford, “Hanslick’s Idealist Materialism,” 179.

134. Nägeli, *Vorlesungen über Musik*, 33; Gadamer, *The Relevance of the Beautiful, and Other Essays*, 23; Hanslick, quoted and translated in Bonds, *Absolute Music*, 8. Bonds provides a rich account of Hanslick’s influences and shifting stance over the latter half of the nineteenth century, revealing the ways in which his “original, holistic conception of absolute music differs fundamentally from the harder-edged formalism that would emerge in subsequent editions of his treatise.” *Ibid.*, 209.

135. “[We] should content ourselves with grasping the general idea [of a program], while leaving the particular to the free play of the imagination.” Brendel, quoted and translated in Hoekner, *Programming the Absolute*, 167.

136. Davies, “Julia’s Gift” 307. Davies’s aperçu chimes with Leslie David Blasius’s claim that the nineteenth-century canon and the lowly piano exercise are interdependent (“The Mechanics of Sensation and the Construction of the Romantic Musical Experience,” 17–18) and, more broadly, with John Durham Peters’s contention that the notion of unmediated, intimate dialogue was itself made imaginable as well as disseminable via technological mediation: “Communication as a person-to-person activity became thinkable only in the shadow of mediated communication.” Peters, *Speaking into the Air*, 6.

137. Caillois, *Les jeux et les hommes*, 35–36; translation in Man, *Play and Games*, 5–6. To phrase Caillois’s point in Aristotelian terms, play exemplifies *praxis* (activity undertaken for its own sake) rather than *poesis* (instrumental activity that leads to the production of a desired object or outcome). On this distinction, see Graeber, *The Utopia of Rules*, 192.

138. See Caillois, *Les jeux et les hommes*, 101–21 (*Man, Play and Games*, 43–55).

139. *Oxford English Dictionary*, s.v. “play” and “work.”

140. “Work consists of whatever a body is *obliged* to do, and . . . play consists of whatever a body is not obliged to do.” Twain, *The Adventures of Tom Sawyer*, 32. Describing the mechanized *ilinx* of roller coasters, railroads, and elevators, Bill Brown makes an analogous observation concerning the technological and affective economies of work and play: “we enjoy what we pay for, we suffer for what we are paid for.” Brown, *The Material Unconscious*, 48.

141. Salen and Zimmerman, *Rules of Play*, 304.

142. *Ibid.*, 304.

143. Foucault, “Nietzsche, Genealogy, History,” 150.

144. *Ibid.*, 139.

145. Ernst, *Digital Memory and the Archive*, 55.

146. Kittler, *Discourse Networks, 1800/Ø00*, 369.

147. See, for instance, Taylor, *The Archive and the Repertoire*; Giannachi, Kaye, and Shanks, *Archaeologies of Presence*; Jones and Heathfi ld, *Perform, Repeat, Record*; and Canning and Postlewait, *Representing the Past*.

148. Schneider, *Performing Remains*.

149. Didi-Huberman, *Confronting Images*, 38.

150. *Ibid.*, 39 (italics in original).
151. Ernst, “From Media History to *Zeitkritik*,” 140–42.
152. See Siegert, *Relays*; and Siegert, *Passage des Digitalen*, 369–417.
153. Krajewski, *Paper Machines*, 8: see also Krapp, “Hypertext *avant la Lettre*.”
154. *Ibid.*, 7. In Karlheinz Stierle’s words, “fiction makes it possible actually to grasp the various modes of perceiving historical experience.” Quoted and translated in Jauss, *Question and Answer*, 26.
155. Krajewski, *Paper Machines*, 27–47.
156. This line of inquiry is pursued throughout Key 3.
157. Westgeest, “Ghiselin Danckerts’ *Ave Maris Stella*.”
158. Nabokov, *The Defense*, 43.
159. On the forging of such epistemological, technological, and historical connections, see Jonson and Cavallaro, *Prefiguring Cyberculture*.
160. Liu, “Transcendental Data,” 72.
161. Winthrop-Young, “Siren Recursions,” 75–77.
162. *Ibid.*, 77.
163. See Key 1–5. On speedrunning, see Scully-Blaker, “A Practiced Practice”; Franklin, “On Game Art, Circuit Bending and Speedrunning as Counter-Practice”; and LeMieux, “From NES-4021 to moSMB3.wmv.”
164. Well-known examples include the “knight’s tour” and the “wheat and chessboard” problems. David Cope posits a musical challenge that is isomorphic to the knight’s tour in “Rules, Tactics and Strategies for Composing Music,” 258.
165. Lull, *Ars generalis ultima*: see also Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 61–78; and Nowviskie, “Ludic Algorithms.” Katelijne Schiltz observes that the *ars combinatoria* accounts both for the mechanics of Danckerts’s *Ave maris stella* and for its theological implications (“Visual Pictorialism in Renaissance Musical Riddles,” 216).
166. See Derrida, “Structure, Sign, and Play in the Discourse of the Human Sciences.”
167. Barthes, “From Work to Text,” 59.
168. *Ibid.*, 63.
169. Huizinga, *Homo Ludens*, 158 (see also Henricks, “Huizinga’s Contribution to Play Studies,” 48); Dreyfus, “Beyond the Interpretation of Music,” 272.
170. See Key 5–5, *note* 165.
171. Celebrating music’s ludic qualities, Dreyfus observes that “human beings are very good indeed at juggling masses of conceptual figures, each tugging at the other’s hegemony, enabling what we know and sparking how we act.” Dreyfus, “Beyond the Interpretation of Music,” 272.

1–3 THE SOUND OF GUNPLAY

172. See Key 5–5, *note* 167.
173. See Smith, *The Total Work of Art*, 157–86; and Summers, “From *Parsifal* to the PlayStation.”
174. See Wright, Embrick, and Lukács, *Utopic Dreams and Apocalyptic Fantasies*.
175. See Cheng, *Sound Play*; Collins, *Game Sound*; Collins, *Playing with Sound*; Miki Kaneda, “*Rhythm Heaven*”; Kayali, “Playing Music”; Miller, *Playing Along*; Tonelli, “Chip-tuning of the World”; the essays collected in Collins, *From Pac-Man to Pop Music*; and those

in Donnelly, Gibbons, and Lerner, *Music in Video Games*, for representative contributions by these authors and others.

176. Galloway, *Gaming*, 85; see also Pearce, “Games as Art,” 71–72.

177. Bourdieu, “The Practice of Reflexive Sociology,” 220.

178. As Hagen puts it, the development of the modern computer from von Neumann’s “arche-structure . . . grew out of . . . the numbers game, out of a game with digits, placeholders, [and] *fort/da* mechanisms.” Hagen, “The Style of Sources,” 173.

179. See von Hilgers, *War Games*, 133–44.

180. McGonigal, *Reality Is Broken*; see also Chatfield, *Fun, Inc.*

181. Dyer-Witheford and de Peuter, *Games of Empire*. On historical, epistemological, and phenomenological connections between games and military technologies, see also Crogan, *Gameplay Mode*; and Halter, *From Sun Tzu to Xbox*.

182. As Lütticken observes, the ubiquitous “gamification” of corporate culture, typified by Google’s “quasi-ludic work environment,” invokes this isomorphism between capitalism and agonistic play conducted according to game-theoretical principles (Lütticken, “Play-times,” 134).

183. Galloway, *Gaming*; Bogost, *Unit Operations*; Bogost, *Persuasive Games*; Bogost, *How to Do Things with Videogames*; Flanagan, *Critical Play*; Pearce, “Games as Art”; and Anthropy, *Rise of the Videogame Zinesters*.

184. On such codes and the types of literacy they represent, see Selfe and Hawisher, *Gaming Lives in the Twenty-First Century*.

185. See Luhmann, “Operational Closure and Structural Coupling,” and the analogous distinction between “technical closure” and “meaning-related openness” adumbrated in his *Introduction to Systems Theory*, 66–67.

186. On Leibniz’s “invention” of binary and his configuration of properties that would become known as “digital” and “analog,” see Key 2–1.

187. Kircher, *Ars magna lucis et umbrae*, 768–69. On Kircher’s navigation between “scientific play” and the arts of magic (both black and white), see Findlen, “Jokes of Nature and Jokes of Knowledge,” 324.

188. Kircher, *Musurgia universalis*, 2:1–09; 2:360–63; and 2:312–59, respectively.

189. Kittler, *Optical Media*, 54–81.

190. Archytas invoked the aulos in conceiving sound as a missile, the ballistic energy of which could be correlated with pitch; see Huffman, *Archytas of Tarentum*, 140–47; Kittler, *Musik und Mathematik*, 1, bk. 1, 34–25; and Key 2–1, notes 51–55.

191. Kittler, *Gramophone, Film, Typewriter*, 97; in *War Games*, von Hilgers retroactively provides Kittler’s assertion with a solid historical and genealogical armature. The etymological entanglement of the ludic and the ballistic in the form of the “play” of ordnance extends back to the sixteenth century; see *Oxford English Dictionary*, s.v. “play.”

192. On the fragmentary history of *Tennis for Two* and its susceptibility to revisionism, see Guins, *Game After*, 96–105.

193. Thomas T. Goldsmith Jr. and Estle Ray Mann had drawn directly on this technology when developing their “Cathode-Ray Tube Amusement Device” in 1947, which simulated the shooting down of airplanes. Although the device was patented (US Patent 2,455,922), it never went into production.

194. See Wood, *Staking Out the Territory*, 1B.

195. In 2014, this genealogical lineage was materialized by Pekka Väänänen, who transduced the graphical output of the influential first-person-shooter (FPS) game *Quake* (1996) into an audible stream of data in order to render the game's vectorized display of ballistic violence on an oscilloscope: see Väänänen, "Quake on an Oscilloscope."

196. On the military applications of the technologies later marketed under the rubric of "hi-fi," see Kittler, *The Truth of the Technological World*, 160–61.

197. Pias, "The Game Player's Duty," 1822; see also Pias, "Children of the Revolution"; and Lerner, "The Origins of Musical Style in Video Games, 1977–1983." *Pong* conveyed its own rules with exemplary economy, instructing players simply to "avoid missing ball for high score."

198. See Lerner, "The Origins of Musical Style in Video Games, 1977–1983."

199. Albright, *Untwisting the Serpent*, 9; see also Wellbery, *Lessing's Laocoön*.

200. Bogost, *Alien Phenomenology*, 103. Bogost's phrase describes the idiosyncratic operation of the Television Interface Adapter of the Atari VCS and its modulation of code into analog televisual signals. In computers such as the MANIAC, built at the Los Alamos Scientific Laboratory in 1952, cathode-ray tubes were used for the purposes of memory rather than display: see Dyson, *Turing's Cathedral*, 145.

201. Ernst, *Sonic Time Machines*, 110. For Ernst, it is "the imperative to treat computing time as discrete [that] conditions the rhythmic bias of digital computation." *Ibid.*, 43.

202. Galloway, *Gaming*, 2. For an alternative approach to the historical ontology of digital games that emphasizes the multiple layers and facets of their materiality, see Guins, *Game After*.

203. Jankélévitch, *Music and the Ineffable*, 78–79; see also Barthes, "Musica Practica."

204. See Bogost, *Persuasive Games*, 295 and 311–3; and Moseley, "Playing Games with Music (and Vice Versa)." Graeme Kirkpatrick also compares the experience of digital gameplay with the performance of instrumental music (*Aesthetic Theory and the Video Game*, 100–101) and dance (*ibid.*, 19–58). On the nongraphical multiplayer game *Johann Sebastian Joust* (2014), which makes use of motion-sensitive controllers in the choreography of riotous agonistic struggle to the pitch-shifted strains of Bach's Brandenburg Concertos, see Sicart, *Play Matters*, 12–14.

205. Jankélévitch, *Music and the Ineffable*, 91; see also Abbate, "Music—Drastic or Gnostic?"

206. On the playful ambivalence to which digital games typically give rise, see Kirkpatrick, *Aesthetic Theory and the Video Game*, 41–42.

1–4 BITS AND BEATS

207. Quoted in Melissinos and O'Rourke, *The Art of Video Games from Pac-Man to Mass Effect*, 25.

208. See Key 5–5, note 169.

209. For an engaging account of ways in which these distinctions have played out within the digital game-world of *The Lord of the Rings Online*, see Cheng, *Sound Play*, 1B–20.

210. For diverse examples of oscillographic and melographic inscriptions and "educations," see Feaster, *Pictures of Sound*.

211. Scott was following in the oscillographical footsteps of Francis North (1677), Thomas Young (1807), and Claude-Servais-Matthias Pouillet (1850): see Feaster, *Pictures of Sound*, 85–89 and 110–12. Scott also drew on the signal contributions of Ernst Florens Friedrich Chladni to techniques and technologies of "writing" sound, as summarized by Thomas Y. Levin ("For the Record," 38–42) and Siegert (*Passage des Digitalen*, 252–55): see also Key

2–2, notes 17–18. On the development of oscillography across a range of scientific, epistemological, and cultural contexts, see Hankins and Silverman, *Instruments of the Imagination*, 1B–47; and Mills, “Deaf Jam,” 42–47.

212. See Fuller Maitland, *Grove’s Dictionary of Music and Musicians*, 1:B6. In 1748, Denis Diderot advocated for this method of notating music in his “Projet d’un nouvel orgue.” See also Freke, “A Letter . . . concerning a Machine to Write Down Extempore Voluntaries” (Freke attributed the invention to “the late Rev. Mr. Creed,” about whom little else is known); Unger, *Entwurf einer Maschine wodurch alles was auf dem Clavier gespielt wird, sich von selber in Noten setzt*; Burney, *The Present State of Music in Germany, the Netherlands, and the United Provinces*, 214–19; Engramelle, *La tonotechnie*, 72; Schleuning, “Die Fantasiermaschine”; Southgate, “On Various Attempts That Have Been Made to Record Extemporaneous Playing”; Ripin et al., *Early Keyboard Instruments*, 185; Richards, *The Free Fantasia and the Musical Picturesque*, 77–81; Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 192–222 and 294–312; and Kassler, “Stanhope’s Novel Musical Instruments.” The “melograph” designed by Jules Carpentier and demonstrated at the Paris International Exposition of Electricity in 1881 shared the function as well as the name of Euler’s machine, providing a telegraphic means of transcribing extemporized music: see Fuller Maitland, *Grove’s Dictionary of Music and Musicians*, 1:B7; Noble, *Forces of Production*, 147–52; and Szendy, *Listen*, 77. On other connotations of “melograph,” see Key 3–4, notes 218–9.

213. On the *Banū Mūsā*, see Farmer, *The Organ of the Ancients from Eastern Sources*, 79–118; and Lehr, “The Automatic Flute Player of the Musa Brothers.” After featuring in sixteenth-century instruments such as the *Salzburger Stier* (1502) of the Hohensalzburg Fortress and the hydraulic organ at the Villa d’Este, Tivoli (ca. 1550), the same technological principle was circulated among makers of clocks, instruments, and automata by the Augsburg organist Erasmus Mayr (see Morsman, “*Quicquid Rarum, Occulatum et Subtile*,” 20–22) and was also illustrated by Kircher (*Musurgia universalis*, 2:347). As Lehr points out, the innovations of the *Banū Mūsā* can even be said to anticipate the Welte-Mignon reproducing piano, while their advocacy of wax as a cylindrical recording medium was belatedly endorsed by Thomas A. Edison. For further historical and technical context, see Haspels, *Automatic Musical Instruments*, 33–107; and Brauers, *Von der Äolsharfe zum Digitalspieler*.

214. Stains, *Phonography*, 184–85.

215. Caus credited “Pierre Filippe” (better known as Peter Philips) with the intabulation of Striggio’s madrigal (Caus, *Von gewaltsamen Bewegungen*, 1:43); see Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 85–89; and Haspels, *Automatic Musical Instruments*, 39.

216. Abbate, *In Search of Opera*, 204.

217. Hillis, “New Computer Architectures and Their Relationships to Physics,” 257: on the “interconvertibility of space and time” in relation to writing, musical notation, computer memory, and phonography, see Peters, *The Marvelous Clouds*, 306–13.

218. On the Jaquet-Droz automata, see Voskuhl, *Androids in the Enlightenment*, 128–45; and Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 327–47. Voskuhl notes that the keyboard played by *la musicienne* today is not that of her original instrument, which was probably a harpsichord or a hybrid harpsichord-organ (*Androids in the Enlightenment*, 130).

219. Terrance Riley, “Composing for the Machine,” 367.

220. In particular, the function of *la musicienne's* “elbows” as hinges that facilitate lateral movement of the “hands” while minimizing vertical motion is in accordance with the advice of Johann Nepomuk Hummel and many other Germanophone pedagogues, as collated and put into practice by Christina Kobb (see Nuwer, “Playing Mozart’s Piano Pieces as Mozart Did”).

221. Abbate, *In Search of Opera*, 204.

222. On “recreation” in this sense, see Key 5–0.

223. On Cornelius Drebbel’s solar-powered automatic virginals as described by John Wilkins, see Gouk, *Music, Science and Natural Magic in Seventeenth-Century England*, 168.

224. Such was the case with the instrument for which Mozart wrote the Adagio and Allegro in F minor, K. 594, and the Allegro and Andante in F minor, K. 608, in 1791: see Richards, “Automatic Genius.”

225. On ludomusical aspects of the Game & Watch, see Moseley and Saiki, “Nintendo’s Art of Musical Play,” 57–58.

226. The cybernetic function of the beeps emitted by the Game & Watch was more important than their timbral quality. In former Nintendo sound designer Hirokazu Tanaka’s words, they were considered necessary “so the player can have timing indications” (quoted in Gorges and Yamazaki, *The History of Nintendo, 1980–1991*, 23). The beeps were deemed so integral to gameplay that they could not be silenced by the player.

227. As Evens puts it, “[to] use digital technologies, one must become digital, aligning one’s own articulations to the spatial, temporal, and logical articulations of the interface. . . . [The] user programs the interface, but the interface also programs the user.” Evens, *Sound Ideas*, 80. In the context of digital games, Ted Friedman makes the analogous observation that “your decisions become intuitive, as smooth and rapid-fire as the computer’s own machinations.” Friedman, “Civilization and Its Discontents,” 136.

228. “Tout ce qui résulteroit sans l’oreille & le goût des meilleurs principes de la Musique, seroit froid, machinal, insipide & inanimé.” Marie-Dominique-Joseph Engramelle, *La tonotechnie*, 3: see also the surrounding chapter (1–7) as well as Engramelle’s prefatory remarks, especially iv–v and xxi–xxv. Engramelle’s treatise has been discussed from different perspectives by Haspels, *Automatic Musical Instruments*, 65–69; Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 294–312; Szendy, *Listen*, 73; Fuller, *Mechanical Musical Instruments as a Source for the Study of “Notes Inégales”*; le Huray, “Dom Bédos, Engramelle, and Performance Practice”; and Feaster, *Pictures of Sound*, 7–18.

229. Engramelle, *La tonotechnie*, 16; “Comme il n’est rien qu’on ne puisse mesurer exactement en musique, il n’est aucune pièce, aucune symphonie, aucuns concerts & enfi aucuns détails qu’on ne puisse noter sur les cylindres avec la plus grande précision.” *Ibid.*, 62.

230. “Aussi le notage . . . n’est autre chose que la manière aisée de calculer la Musique; d’en mesurer les notes par des chiffres, & de diviser la circonférence des cylindres en autant de parties égales, dont on peut avoir besoin, pour appliquer dessus les cloux à des distances précises & régulières, & les y disposer de façon à exécuter avec goût & précision les pièces de Musique qu’on veut faire jouer par ces machines.” *Ibid.*, xxiii–xxiv: see also *ibid.*, 61–62.

231. *Ibid.*, 15–36 and vi. On Engramelle’s terminology and diagrammatic notation, see le Huray, “Dom Bédos, Engramelle, and Performance Practice.”

232. Engramelle provided illustrative calculations to aid readers with the partitioning of cylinders into the appropriate number of divisions, from measures to *modules*: see *La tonotechnie*, 73–82.

233. Pias, "The Game Player's Duty," 179-80.

234. Quoted and translated in Kittler, *The Truth of the Technological World*, 152.

235. Csíkszentmihályi, *Flow*. It is telling that the concept of flow has been applied to digital games as well as to musical performance and pedagogy: see Chen, "Flow in Games"; Hytönen-Ng, *Experiencing "Flow" in Jazz Performance*; and Pierce, *Deepening Musical Experience through Movement*, 178-86.

236. Wilkins, *Mercury, or the Secret and Swift Messenger*, 141-44; on Chudy, see Zielinski, *Deep Time of the Media*, 185. On François Sudre's subsequent attempt to introduce a "langue musicale universelle," or "téléphonie," based on the permutation of "the seven musical pitches," see van Rij, "A Living, Fleshy Bond," 149-51.

237. Raykoff, *Dreams of Love*, 26-27.

238. Baudot's code was used by the German army's Lorenz *Schlüsselzusatz* cipher machines during the Second World War before being extended to seven bits and codified as the American Standard Code for Information Interchange (ASCII) in 1963.

239. The automated loom was pioneered by Bouchon before its mechanical operation and method of programming were refined by Vaucanson (see Prelude, note 9) and Joseph-Marie Jacquard. On its implications for the automated recreation of music, see Moseley, "Playing Games with Music (and Vice Versa)," 294-300; Moseley and Saiki, "Nintendo's Art of Musical Play," 62-66; Key 5-1, note 47; and Key 5-2, note 96.

240. As Ernst puts it, "symbolically encoded information" represents "the essence of digital computers and . . . the cultural technique of preserving musical information despite the evanescence of acoustic articulation." Ernst, *Sonic Time Machines*, 90. This parallel has been drawn in relation to Charles Babbage's Analytical Engine (1834-71), Herman Hollerith's tabulating machine (ca. 1890), and Turing's universal machine: see, for instance, Suisman, "Sound, Knowledge, and the 'Immanence of Human Failure'"; and Goble, *Beautiful Circuits*, 169.

241. For definitions and demonstrations of media archaeology, see Huhtamo and Parikka, *Media Archaeology*; Parikka, *What Is Media Archaeology?*; and Zielinski, *Deep Time of the Media*.

242. Galloway, *The Interface Effect*, 23. Even within a single realm, such "possible actions" can be at once homologous and widely divergent in form and function. In the cryptographic sphere, for instance, the "musical" overtones of the systems of transmission developed by Wilkins, Chudy, and Baudot are reciprocated by the fact that the ostensibly musical *Guitar Hero* controller and notational system have recently been adapted to facilitate the subconscious acquisition and retrieval of passwords: see Hristo Bojinov et al., "Neuroscience Meets Cryptography."

243. As evidence for the "touching" attributes and effects of the telegraph as an instrument of desire and romance, see Johnston, *Lightning Flashes and Electric Dashes*. For commentary, see Otis, *Networking*, 133-79; Stubbs, "Telegraphy's Corporeal Fictions"; and Raykoff, *Dreams of Love*, 27. On the social, performative, and affective potential of the *Guitar Hero* controller and its five-bit fret buttons, see Miller, *Playing Along*, 85-151.

244. Suits, *The Grasshopper*, 55.

245. See Key 1-0, note 9.

1-5 PLAYING UNDEAD

246. Nietzsche's writings have most explicitly infiltrated the digital game in the form of Monolith Soft's *Xenosaga* trilogy of role-playing games (2002-06), the episodes of which are subtitled *Der Wille zur Macht*, *Jenseits von Gut und Böse*, and *Also sprach Zarathustra*.

247. See Key 5–5, *note* 168.

248. On *Rez*, see Shinkle, “*Corporealis Ergo Sum*”; and Svec, “Becoming Machinic Virtuosos.” On *L.A. Noire*, see Beverburg Reale, “Transcribing Musical Worlds”; on *Donkey Kong Jungle Beat*, see Robertson, “One More Go.” On the rhythmic attributes of digital gameplay in general, see Kirkpatrick, *Aesthetic Theory and the Video Game*, 73–79; Apperley, *Gaming Rhythms*; Väliaho, *Biopolitical Screens*, 29–31; and Sudnow, *Pilgrim in the Microworld*.

249. “Emancipirt die Vierteltöne, so habt ihr eine neue Tonwelt! . . . An dieser mysteriösen Pforte scheint Chopin zu rütteln. . . . Ist einmal diese Pforte gesprengt, so sind wir abermals um einen Schritt näher den ewigen Naturlauten.” Kinkel, *Acht Briefe an eine Freundin über Clavier-Unterricht*, 78–79.

250. “[Seine] Melodien schleichen widerstrebend durch die halben Töne, als tasteten sie nach feinern, vergeistigtern Nüancen, als die vorhandenen feinen Intentionen bieten.” *Ibid.*, 78–79.

251. Siegert, *Cultural Techniques*, 98–100; see also Kittler, *Optical Media*, 61–62.

252. See, for instance, Hirt, *When Machines Play Chopin*.

253. *Chronos* and *kairos* are here deployed in light of Piekut’s invocation of the dyad when distinguishing between indeterminacy and improvisation (“Chance and Certainty,” 156).

254. The anecdote is recounted in Niecks, *Frederick Chopin as a Man and Musician*, 2:42.

255. Nicholas Cook reports that at a competition seeking the fastest performance of the “Minute” waltz on a Ferrari-red piano at London’s Royal College of Music in 2010, the winner brought down the checkered flag at 53 seconds (*Beyond the Score*, 35n5).

256. For a penetrating treatment of touch, sensitivity, and other Chopinesque attributes, see Davies, *Romantic Anatomies of Music*, 51–57.

257. Adorno, “Drehorgel-Stücke,” 38; “Aber es ist nicht jenes beliebte ‘Tempo der Zeit,’ das sie auf ihrer Walze führen. Sondern der hastige Zugriff, mit welchem sie sich alles herrenlosen Musikgutes bemächtigen, verwandelt es durch Zauberei ins Vorgeschichtliche.” *Ibid.*, 37; see also Abbate, *In Search of Opera*, 202–5.

258. See, for instance, *HarmoKnight* (2012–B) and *Theatrhythm Final Fantasy* (2012).

259. On Chopin’s otherworldly qualities, see Kallberg, “Small Fairy Voices.”

260. Agamben, *Infancy and History*, 93.

261. On *Eternal Sonata*, see Fritsch, “Worlds of Music,” 173–75.

262. In the terms of Walter Benjamin’s materialistic historiography, such objects evince a “monadological structure” that demands to be “blasted out of the continuum of historical succession.” Benjamin, *The Arcades Project*, 475. On objects that object, see von Foerster, *The Beginning of Heaven and Earth Has No Name*, 124–25.

263. Ernst, *Digital Memory and the Archive*, 55.

264. Caus, *Von gewaltsamen Bewegungen*, 2:65, plate 15; see McIntosh, *Gardens of the Gods*, 71–74; and Riskin, “Machines in the Garden,” 38–39. The contest between Apollo and Pan was musically recreated by J.S. Bach in *Der Streit zwischen Phoebus und Pan*: see Key 1–1, *note* 73.

265. “Relikte vergessener Zeiten, dürfen sie das Banale in das Heilige fügen.” Adorno, “Drehorgel-Stücke,” 37.

266. “Leicht könnten sie zu den großen Barockorgeln sich verhalten wie die Puppenspiele zu den Trauerspielen.” *Ibid.*, 38.

267. In 1752, Archbishop Andreas Jakob von Dietrichstein solidified the connection between puppet show and barrel organ by adding to the Hellbrunn Palace’s wonders an elaborate mechanical theater featuring 141 figures whose water-powered motion is

accompanied by a hydromechanical organ. In its local context, this organ's pinned barrel can be traced back to the *Salzburger Stier*, for which Leopold Mozart helped provide musical programming: see Brauers, *Von der Äolsharfe zum Digitalspieler*, 17–18 and 29–30.

268. On Sittikus, see Riskin, “Machines in the Garden,” 37–39; for Philostratus's ekphrasis, see Key 1-1, note 101. There is one important difference in Sittikus's staging: rather than delegating Marsyas's punishment to the knife-grinder, Apollo is poised to administer it himself.

269. Agamben, *Infancy and History*, 80.

270. Flusser, *Into the Universe of Technical Images*, 161–63. In a similar vein, Zielinski draws attention to the interactivity of digital play, whose players become “producers of the narrative . . . that they themselves select. The creation of something unique is no longer the prerogative of the work but is delegated to the participant/player.” Zielinski, *Audiovisions*, 303.

271. Adorno, *Einleitung in die Musiksoziologie*, 97–98.

272. *Ibid.*, 98.

273. See Key 2-4, note 197. As Chua observes, the London Philharmonic Society was founded in 18B on the basis of musical amateurism: the payment of all members and associates was expressly prohibited (“Myth,” 199–200). As with sporting amateurism (on which see Porter and Wagg, *Amateurism in British Sport*), such arrangements proved to be socio-economically unsustainable as the nineteenth century wore on.

KEY 2 DIGITAL ANALOGIES

1. Some keyboard instruments (such as the carillon) and techniques (such as the performance of clusters) require the use of fists and other configurations of the hand: see Vaes, “The ee Centuries of Keyboard Clusters.”

2. See Key 5-5, note 170.

3. See Lewis and Short, *A Latin Dictionary*, s.v. *digitus*, and *Oxford English Dictionary*, s.v. “digit.”

4. *Oxford English Dictionary*, s.v. “digital.” At the organ console, the relationship between “digital” and “manual” is thus analogous to that between key and keyboard as well as finger and hand.

5. See Plautus, *Miles gloriosus* 2.2; Cicero, *In Q. Caeciliam Oratio Quae Divinatio Dicitur* 14.45 (in *The Verrine Orations*); Cicero *Letters to Atticus* 5.21; Ovid, *Fasti* 3.123; Pliny the Elder, *Natural History* 34.8 and 2.23; and Quintilian, *The Orator's Education* 11.3.8.

6. “[Das] Zählen ist älter als die Zahl.” Macho, “Zeit und Zahl,” 179. The ancient Sumerians deployed a duodecimal system based on the twelve phalanges (finger bones) in each hand. The mnemonic device of the Guidonian hand relies on the same physiological features, as does the *main harmonique* that, according to the eighteenth-century missionary Joseph Amiot, served as an aide-mémoire in relation to the twelve *lü* (*Mémoire sur la musique des Chinois*, plate 17).

7. See Evens, *Sound Ideas*, 11–14 and 63–125.

8. Gary Tomlinson describes the combinatorial processing of melody, which relies on the perception of metrical and rhythmic hierarchies as well as the differentiation and organization of pitch, as a “digital mode [reflecting] a kind of cognition that first appears, in the archaeological record, in the construction of composite tools.” Tomlinson, *A Million Years of Music*, 169.

9. Liddell and Scott, *A Greek-English Lexicon*, s.v. ἀνάλογος; *Oxford English Dictionary*, s.v. “analogue.” On analogy in the context of ancient philosophy and science, see Lloyd, *Polarity and Analogy*. For contemporary perspectives on the importance of analogy, see Descola, *Beyond Nature and Culture*, 201–31; Hofstadter and Sander, *Surfaces and Essences*; Schleifer, *Analogical Thinking*; and Silverman, *Flesh of My Flesh*, 1–4.

10. *Morra*, known to the Romans as *micare digitis* (“to flash with the fingers”), is played in order to arrive at decisions or simply for entertainment. Chopsticks—also known as “swords,” “sticks,” and “fingers”—is a game of strategy and calculation for two reputed to have originated in Japan.

11. Having initially given a proof of his minimax theorem in 1928, von Neumann provided a complementary one in von Neumann and Morgenstern, *Theory of Games and Economic Behavior*.

12. On the musical role-play afforded by *The Lord of the Rings Online*, see Cheng, *Sound Play*, 1B–37; on the improvisatory and procedural means by which role-playing emerges and is performed across a variety of ludic contexts, see Pearce, “Role-Play, Improvisation, and Emergent Authorship.”

13. Comanini, *Il Figino*, 73–75. In Comanini’s dialogue, the claim is ascribed to Guazzo, who proceeds to claim that Palamedes, the mythical inventor of backgammon, intended the game’s twelve rows, seven pieces, board, and dice shaker to represent the signs of the zodiac, the planets, the benighted human domain, and the heavenly whims of the gods, respectively (*ibid.*, 75–76). On the “semiology” of chess (as opposed to the “pure strategy” of Go), see Deleuze and Guattari, *A Thousand Plateaus*, 352–53.

14. Mindell, *Between Human and Machine*, 39; see also Buckley, “Analog versus Digital.”

15. Wark, *Gamer Theory*, paragraph 97. Galloway poses the same problem (and offers his own solution by way of an extended gloss on the “anti-digital” philosophy of François Laruelle) in *Laruelle*, esp. 71, 172, and 219–21.

16. Wilden, *System and Structure*, 168; see also 166–67n8 and 191–95. Conversely, “reality” for Wilden “has no purpose in explanation, no purpose to explain.” *Ibid.*, 178.

17. Evens, *Sound Ideas*, 71. Galloway describes the “operation of the digital” as “the making-discrete of the hitherto fluid, the hitherto whole, the hitherto integral.” Galloway, *Laruelle*, 52.

18. In a similar vein, see Massumi, *Parables for the Virtual*, 133–43; and Rothenbuhler and Peters, “Defining Phonography.”

19. See Descola, *Beyond Nature and Culture*, 85–88; and von Foerster, *The Beginning of Heaven and Earth Has No Name*, 11–12.

20. Flusser, *The Shape of Things*, 62.

21. As Wilden observes, the question of whether a system is “digital” or “analog” is “never an objective fact, but the result of a definition made by some subsystem in the wider ecosystem.” Wilden, *System and Structure*, 159.

22. See Siegert, “Cacography or Communication?” 30; and Key 1–0, note 49.

23. In “L’escarpolette,” the dreamy alternation of arpeggios in contrary motion evokes the hypnotic oscillation of a swing. On *Jeux d’enfants*, see Key 1–1, note 107; and Key 5–0.

24. Ernst, “From Media History to *Zeitkritik*.”

25. As Manuel De Landa puts it, “the most stable and durable traits of our reality . . . merely represent a *slowing down* of . . . fl wing reality.” De Landa, *A Thousand Years of Nonlinear History*, 258.

2-1 APOLLO 1, MARSYAS 0

26. Kittler, "Number and Numeral," 57: see also Ernst, *Digital Memory and the Archive*, 175-78 and 185-86.

27. Evens, *Sound Ideas*, 73-74.

28. Kittler, *The Truth of the Technological World*, 26: see also *ibid.*, 54. Kittler's nemesis Adorno agreed that "the Greek artistic relationship to violence mirrors the origin of the artistic in the same." Adorno, *Towards a Theory of Musical Reproduction*, 58.

29. Callimachus, *Hymn 2 (to Apollo)*, lines 105-12: see also Bing, "Impersonation of Voice in Callimachus' *Hymn to Apollo*," 192-94; Hunter and Fuhrer, "Imaginary Gods?," 150-57; and Fantuzzi and Hunter, *Tradition and Innovation in Hellenistic Poetry*, 358. Callimachus's hymn enacts a sophisticated critique of its own hexameter form: see Bassi, "The Poetics of Exclusion in Callimachus' *Hymn to Apollo*"; and Cheshire, "Kicking ΦΘΟΝΟΣ."

30. *Hanc primum veniens plectro modulatus eburno / felices cantus ore sonante dedit. / Sed postquam fuerant digiti cum uoce locuti, / edidit haec dulci tristia verba modo.* Lygdamus, *Corpus Tibullianum* 3.4.39-42. I am grateful to Matthew Carter for the following translation: "Strumming this [lyre] epiphanically with a pick made of ivory / he produced glad songs in a booming voice. / But after his fingers had spoken together with his mouth, / he sang forth these melancholy words in a lovely mode."

31. For the Greeks, lyric poetry was defined as such by its kitharedic accompaniment, whereas elegies were accompanied by the aulos: see Bowie, "Early Greek Elegy," 27.

32. These attributes help explain why the design of the harpsichord and the very name of its vertical counterpart, the clavicytherium, can be traced back to Apollo's legendary kithara. This relationship was observed by Vincenzo Galilei, who contended that the harpsichord was "nothing but a horizontal harp," which, in turn, was "nothing but the ancient kithara." Galilei, *Dialogo della musica antica e della moderna*, 143.

33. Aristides Quintilianus, *On Music* 2.18-9.

34. *Ibid.*, 2.19: see also Mathiesen, *Apollo's Lyre*, 553-54. It is in this light that Lydia Goehr ponders the larger metaphorical significance of *agōn*, observing that "the opposition between string- and wind-play can be used to forge a mythic, moral, and metaphysical sword for use in the general disciplining of humanity." Goehr, "—wie ihn uns Meister Dürer gemalt!," 65. The opposition of string and wind instruments, which Aristotle addresses in his *Politics*, can be mapped onto the worship of Apollo among Dorians and Cybele in Phrygia: see Maniates, "Marsyas Agonistes"; Van Keer, "The Myth of Marsyas," 22-23; and Hamilton, *Music, Madness, and the Unworking of Language*, 38-39.

35. Aristides Quintilianus, *On Music* 2.17.

36. Albright, *Untwisting the Serpent*, 19.

37. Flusser lauded such procedures for their ability to render mathematics tangible, even synaesthetic: "now that one can re-code numbers in the form of colours, shapes and sounds with the aid of computers, the beauty and depth of calculation are there for all to feel." Flusser, *The Shape of Things*, 64.

38. Leibniz, *Dissertatio de arte combinatoria*. En route from Lull to Leibniz, Francis Bacon and Wilkins played important roles in the development and dissemination of combinatorial thought and practice as well as music theory and acoustics. See Gouk, *Music, Science and Natural Music in Seventeenth-Century England*, 157-223; and Siegert, *Passage des Digitalen*, 120-36, for adroit descriptions and contextualization of the activities of

Bacon, Wilkins, and their fellow members of the Royal Society across the domains of music, acoustics, algebra, cryptography, and logic.

39. This thesis, articulated by Stains in 1842 (*Phonography*, 178), is energetically prosecuted throughout Kittler's *Musik und Mathematik*: see also Kittler, *The Truth of the Technological World*, 259–74. On auletic epistemology, see Hagel, "Twenty-Four in Auloi."

40. Kittler, *The Truth of the Technological World*, 265; Kittler, "Number and Numeral," 56; and Kittler, *Musik und Mathematik*, 1, bk. 1, 320–28. Kittler was presumably alluding to Philolaus's fragment 6a, reproduced and translated in Huffman, *Philolaus of Croton*, 145–47, which refers to the manual measurement of strings (if not explicitly to the lyre).

41. See Key 1–1, note 61: see also Silverman on Ovid's telling of the lives, deaths, and afterlives of Orpheus and Eurydice (*Flesh of My Flesh*, 2–7).

42. Albright, *Untwisting the Serpent*, 19.

43. For Aristotle, the *diesis* constituted the musical monad despite the fact that it was not always numerically singular (see the translation of and commentary on *Metaphysics* 1016b, 18–24, and 1053a, 12–17, in Barker, *Greek Musical Writings*, 2:72–73). On the etymology of *diesis*, see Hagel, *Ancient Greek Music*, 443; Benson, *Music: A Mathematical Offering*, 171n5; and Pestic, *Music and the Making of Modern Science*, 66–67. On its rehabilitation at the hands of Cardano (see Key 1–0, note 2) and Nicola Vicentino (see Key 2–4, note 208), see *ibid.*, 59 and 67–69 respectively.

44. *Et modo dimittit digitis, modo concipit auras*. Ovid, *Fasti* 6.705.

45. Theweleit, "Monteverdi's *L'Orfeo*," 169: see also Chua, "Untimely Reflections on Operatic Echoes," 578–79; Ernst, "Der Appell der Medien," 182; and Butler, *The Ancient Phonograph*, 64–87. Agostino Agazzari deployed a similar Echo effect in *Eumelio* (1606), a *dramma pastorale* composed one year before Monteverdi's opera.

46. Multitrack recording was developed independently by José Val del Omar in 1947 and Ross Snyder in 1955: on Snyder, see Stanyek and Piekut, "Deadness," 24–25.

47. "Quid me mihi detrahis?" inquit; / "a! piget, a! non est" clamabat "tibia tanti." Ovid, *Metamorphoses* 6.385–86.

48. See Key 1–3. On structural relationships between games and violence, see Evens, "The Logic of Digital Gaming"; and Galloway, "StarCraft, or, Balance." On their musical dimensions, see Cheng, *Sound Play*, 36–55; and Moseley, "Music, Visual Culture, and Digital Games." Recent examples of digital games that map rhythmic input onto the graphic representation of agonistic conflict by merging elements culled from rhythm-action, shooting, fighting, and roguelike genres include Harmonix Music Systems' *A City Sleeps* (2014); SNK Playmore's *The Rhythm of Fighters* (2014); Zen Studios' *KickBeat* (2013–14); and Brace Yourself Games' *Crypt of the NecroDancer* (2015).

49. Pias, "The Game Player's Duty," 179. Pias echoes both Wittgenstein's observation that any "system of game rules" does not determine the meanings or consequences of the maneuvers it regulates (quoted and translated in von Hilgers, *War Games*, 118) and Luhmann's systemic concept of operational closure (see Key 1–3, note 185).

50. North, *Memoirs of Musick*, 59–60: see also Borthwick, "The Riddle of the Tortoise and the Lyre"; Hamilton, *Music, Madness, and the Unworking of Language*, 40; and Hamilton, "Torture as an Instrument of Music," 145–46. Hanslick was pithily unsentimental on this matter: "das Tier, dem die Musik am meisten verdankt, ist nicht die Nachtigall, sondern das Schaf." Hanslick, *Vom Musikalisch-Schönen*, 191.

51. See McIntosh Snyder, “The *Harmonia* of Bow and Lyre in Heraclitus Fr. 51 (DK).”

52. Edward F. Rimbault, annotation to North’s *Memoirs of Musick*, 59n: see also E. Kerr Borthwick, “‘The Wise Man and the Bow’ in Aristides Quintilianus.” Don Ihde notes correspondences in the practice of archery between prehistoric sub-Saharan Africa, ancient China, and medieval England, observing that where bows and arrows were prevalent in hunting and warfare, there is often concomitant evidence that they also performed musical functions: the play of the bow and the twang of the string combined to form what Ihde calls a “multistable” configuration of a set of objects and chains of actions that constitute a weapon in one hand and a musical instrument in another (*Embodied Technics*, 21–26). On the analogous isomorphism of weapons and agricultural tools (not to mention the association of the former with affective “free motion” and the latter with “work”), see Deleuze and Guattari, *A Thousand Plateaus*, 395–403.

53. κείνος οἰστειτὴν ἔλαχ’ ἀνέρα, κείνος ἀοιδὸν / Θοιβῶ γὰρ καὶ τόξον ἐπιτρέπεται καὶ ἀοιδή . . . εὐφημεῖ καὶ πόντος, ὅτε κλείουσιν ἀοιδοὶ / ἢ κίθαρην ἢ τοξά, Λυκωρέος ἔντεα Φοῖβου. Callimachus, *Hymn 2 (to Apollo)*, lines 43–44 and 18–᠔; translation in Cheshire, “Kicking ΦΘΟΝΟΣ,” 361. Callimachus described both bow and lyre as ἔντεα, which can be translated as both “fitting gear” and “musical instruments.” See also Kittler, *Musik und Mathematik*, 1, bk. 1, 85–88, and his gloss on the punishment exacted by Odysseus on Penelope’s suitors: “Struck by the arrows of his bow, the suitors fall loud and hard to the ground, but the bowstring itself sings as beautifully as a swallow.” *Ibid.*, 323; translation in Peters, “Assessing Kittler’s *Musik und Mathematik*,” 34–35.

54. In *De architectura*, Vitruvius recommended that architects understand the physics of sound in order to ensure, among other things, that “catapult strings are stretched in unison” (quoted and translated in Williams, *The Organ in Western Culture, 750–1250*, 235): see also Kittler, *Musik und Mathematik*, 1, bk. 1, 331–2. On Archytas, see Key 1–3, note 190.

55. See Apollodorus of Damascus, “Les poliorcétiques d’Apollodore de Damas composées pour l’empereur Hadrien,” 268; Huffman, *Archytas of Tarentum*, 140–47; and Kittler, *Musik und Mathematik*, 1, bk. 1, 32.

56. See, for instance, Beethoven’s *Wellingtons Sieg*, op. 91 (18B), initially composed for Johann Nepomuk Maelzel’s mechanical “panharmonicon,” and Liszt’s *Hunnenschlacht* (1857). Comparing the sections of Wagner’s orchestra to the infantry, cavalry, and artillery that compose a military division (*The Truth of the Technological World*, 134–35), Kittler echoed Castil-Blaze’s account of Giacomo Meyerbeer’s operatic strategy: “It was necessary to strike a great blow, and Meyerbeer armed himself with the entire artillery of the orchestra.” Castil-Blaze, quoted and translated in Dolan and Tresch, “A Sublime Invasion,” 16. See also Berlioz’s fantastical description of Euphonia, a twenty-fourth-century German town whose inhabitants are devoted to all aspects of music and which, for reasons Berlioz deemed too obvious to explain, is under the rule of a military dictatorship (*Les soirées de l’orchestre*, 320–27), and the anonymous caricature published in 1842 depicting Liszt’s military triumph over “General Bass” in which the antagonists enlist notes and other musicographical symbols to do battle on their behalf (reproduced in Gooley, *The Virtuoso Liszt*, 38).

57. Albright, *Untwisting the Serpent*, 18.

58. *Salientia viscera possis / et perlucentes numerare in pectore fibras*. Ovid, *Metamorphoses* 6.390–91.

59. In Mathiesen’s summary, “the human body is composed of membranes, sinews, and breath. In consequence, it has the capacity to respond through a kind of sympathetic resonance between the sinews and stringed instruments.” Mathiesen, *Apollo’s Lyre*, 161.

60. See Feldherr, “Flaying the Other,” 82–83; and Hamilton, *Music, Madness, and the Unworking of Language*, 39–41.

61. Ovid, *Fasti* 6.707.

62. Philippe Lacoue-Labarthe’s gloss on Friedrich Hölderlin’s gnomic observation that “in tragedy ‘the sign = 0’” is revealing in this regard: “Nothing better presents the presentation of the Absolute than tragedy.” Lacoue-Labarthe, *Le théâtre de Hölderlin*, 49–50.

63. On the fraught history of “nothing” in Greek thought, see Rotman, *Signifying Nothing*, 60–63.

64. Leibniz, “Explication de l’arithmétique binaire,” 223.

65. Rotman, *Signifying Nothing*, 105–7; see also Lenzen, “Leibniz on Properties and Individuals.”

66. Bacon, *Of the Advancement and Proficiency of Learning*, 266.

67. Penelope Gouk notes that this form of musical encipherment had been deployed by Spanish and Italian diplomats in the sixteenth century before being codified by Giambattista della Porta in 1606 (*Music, Science and Natural Magic in Seventeenth-Century England*, 135). Far earlier, Aristides Quintilianus disclosed that the use of musical codes enabled Roman military commands to be relayed discreetly and immediately (see Mathiesen, *Apollo’s Lyre*, 546). See also Steve Goodman’s account of the use of sound as enciphered communication and affective weapon in the asymmetrical Jamaican conflict between native Maroons and English colonists that took place in the late eighteenth century (*Sonic Warfare*, 65–66). Eileen Southern observes that in the American South, African slaves were denied access to musical instruments such as drums and horns that were deemed capable of transmitting signals in this manner (*The Music of Black Americans*, 172).

68. I take advantage here of Bacon’s archaic spelling of “onely.”

69. Quoted in Siegert, *Passage des Digitalen*, 225, and discussed on 226. I am grateful to Peter McMurray for bringing this passage to my attention. Leibniz’s insight was romantically reformulated by Hegel: “ein Daseyn, das verschwindet, indem es ist” (quoted in Rehdig, “The Discovery of Slowness in Music,” 211).

70. See Kittler, *The Truth of the Technological World*, 180–81; and Galloway, *Laruelle*, xxix.

71. Bateson, “Form, Substance, and Difference,” 459.

72. On the former point, see Kittler, “There Is No Software,” 150; Chun, “Programmability”; and Kirschenbaum, *Mechanisms*, 89–90.

73. In Wilden’s words, “translation from the analog to the digital often involves a gain in information (organization) but a loss in meaning” (*System and Structure*, 168); see also Evens, *Sound Ideas*, 85; von Foerster, *The Beginning of Heaven and Earth Has No Name*, 124–25; and *Key 5–5*, note 17L.

2-2 NOTES ON KEYS

74. On the maximal connectivity of waves and beings, in distinction to the relative isolation necessary for switching systems to operate effectively, see Kittler, “There Is No Software,” 153–54.

75. See Leibniz, *La monadologie*; Deleuze, *The Fold*, 12–B; and Siegert, *Passage des Digitalen*, 240–52. With regard to biology, von Neumann believed that both entire organisms and their internal systems combined digital and analog principles in different proportions: see *The Computer and the Brain*, 68–69, and “The General and Logical Theory of Automata,” 296.

76. Heller-Roazen, *The Fifth Hammer*.

77. Boethius, *De institutione arithmetica* 1.1.10; translation in Heller-Roazen, *The Fifth Hammer*, 22.

78. See Hicks, “Pythagoras and Pythagoreanism in Late Antiquity and the Middle Ages,” 422–24. Kittler suggests that the complementarity of the quadrivium’s four disciplines can be traced back to the mathematical, acoustical, and astronomical activities of Archytas (*Musik und Mathematik*, 1, bk. 1, 35–28): see also Pestic, *Music and the Making of Modern Science*, 14.

79. Heller-Roazen, *The Fifth Hammer*, 46–49; Marie-Elisabeth Duchez, “Des neumes à la portée,” 39–40. For a nuanced account that pays greater attention to material practices and literary factors, see Haines, “The Origins of the Musical Staff.”

80. Cohen, “Notes, Scales, and Modes in the Earlier Middle Ages,” 346; see also Stains, *Phonography*, 169–70.

81. See Mengozzi, *The Renaissance Reform of Medieval Music Theory*, 5–7.

82. On the origins of the organ keyboard, which was first described by Hero of Alexandria, see Marshall, “The Development of the Organ Keyboard.” It is as telling as it is implausible that the very “invention” of the key has long been attributed to none other than Guido of Arezzo: see, for instance, Türk, *Klavierschule*, 4; and Brinsmead, *The History of the Pianoforte*, 85.

83. On Keck’s instrument, see Brauchli, *Th Clavichord*, 42; on Conrad of Zabern’s, see Gümpel, “Das Tastenmonochord Conrads von Zabern”; on Gallicus’s, see Mengozzi, *The Renaissance Reform of Medieval Music Theory*, 146–48.

84. See Wilden, *System and Structure*, 191–94.

85. Along these lines, and in the context of staff notation and tablature as representational systems in the seventeenth century, Gouk argues that “modern understandings of tonality have their origins in keyboard practice of this period.” Gouk, *Music, Science and Natural Magic in Seventeenth-Century England*, 17. On the staff’s more immediate impact, see Cohen, “Notes, Scales, and Modes in the Earlier Middle Ages,” 308.

86. “Il nostro instrumento, questo ha da essere la nostra cartella” (Diruta, quoted in Guido, “Counterpoint in the Fingers,” 65); “Denn die Lage, Ordnung und Reihe der Klänge ist nirgends so deutlich und sichtbar, als in den tasten eines Claviers” (Mattheson, *Der vollkommene Capellmeister*, 106). As Scherer points out, Jean-Philippe Rameau made a similar observation regarding the keyboard’s presentation of “tous les Sons qui peuvent entrer dans la Composition des Ouvrages de Musique” (quoted in Scherer, *Klavier-Spiele*, 29).

87. “[Die Orgel] drang aber dann in die Klöster und klosterartig organisierten Domkapitel, die Träger alles musikalischen Rationalismus innerhalb der Kirche, und wurde dort, scheint es—und das ist wichtig—namentlich auch für den Musikunterricht benutzt.” Weber, *Die rationalen und soziologischen Grundlagen der Musik*, 86; see also *ibid.*, 78 and 88. Weber’s approach to the keyboard is pursued throughout Scherer’s *Klavier-Spiele* and frames Grete Wehmeyer’s account of Carl Czerny’s pedagogy (*Carl Czerny und die Einzelhaft am Klavier*); it also chimes with Siegert’s definition of the grid as a means of making worldly phenomena addressable and manipulable as data (*Cultural Techniques*, 98).

88. See Kittler, *Discourse Networks, 1800/1900*, 3–173. In a musical context, these symbolic and commutative properties also caught Adorno’s attention: for him, the term “key” [*Schlüssel*] (in all languages) indicated that “the musical image should mean *exactly* this or that. And one could say that the path of interpretation is the reverse of encoding. The key

tells us: the image is a symbol for this; interpretation tells us: the symbol is an image of that.” Adorno, *Towards a Theory of Musical Reproduction*, 94.

89. See John Daverio’s discussion of Jean Paul’s punning on musical ciphers in his novel *Die Flegeljahre* (*Crossing Paths*, 97) and John T. Hamilton’s gloss on Hoffmann’s “Kreislers musikalisch-poetischer Klubb” from *Kreisleriana* (*Music and the Unworking of Language*, 183–85). On the intersection of Jean Paul’s and Schumann’s analogical and metaphorical communicative strategies, see also Reiman, *Schumann’s Piano Cycles and the Novels of Jean Paul*; and Watkins, *Metaphors of Depth in German Musical Thought*, 86–118.

90. Quoted and translated in Daverio, *Crossing Paths*, 75.

91. See Key 1–4, note 236.

92. On the entangled biographical circumstances from which *Carnaval* emerged, see Gauldin, “Tragic Love and Musical Memory,” [10]–[12]; see also Rosen, *The Romantic Generation*, 221–22, as well as his discussion of Schumann’s *Variations on the Name “Abegg,”* op. 1, and *Humoreske*, op. 20 (*ibid.*, 7–12).

93. For examples of Sams’s approach, see his “Did Schumann Use Ciphers?”; “The Tonal Analogue in Schumann’s Music”; and the other articles to which Daverio referred over the course of his critical evaluation of Sams’s premises and claims (*Crossing Paths*, 65–124).

94. Winthrop-Young, *Kittler and the Media*, 33–34.

95. Kittler, *Discourse Networks, 1800/1900*, 27–53; on the analogous role played by the clavichord vis-à-vis the formation of the musical self, see Scherer, *Klavier-Spiele*, 103–6. With regard to Schumann, Watkins critically engages with Kittler’s ideas in “The Floral Poetics of Schumann’s *Blumenstück*, Op. 19.”

96. Slavoj Žižek applies a Lacanian gloss to Rosen’s readings (see note 90 above) in *The Plague of Fantasies*, 192–212. While most pianists opt not to perform “Sphinxes,” notable exceptions on record include Alfred Cortot and Rachmaninoff (Audio 2), who bathed them in mystical tremolos to expose what Žižek heard as obscene traces of the real (*ibid.*, 207). Bypassing the keyboard altogether, Romanian pianist Herbert Schuch sounds the “Sphinxes” by reaching inside the piano to manipulate the relevant strings directly. On the complex relation of musical mediation at the keyboard to Kittler’s mapping of linguistic and literary discourse networks ca. 1800, see Gooley, “Stormy Weather,” 233–35.

97. Pierce, “To Write with the Rapidity of Inspiration.”

98. Eisenmenger, *Traité sur l’art graphique et la mécanique appliqués à la musique*; Adorno, *Mélographie, ou nouvelle notation musicale*. On melography, see Key 1–4, note 212; and Key 3–4, notes 218–9. Similar keyboard-based notational reforms were later proposed by Ferruccio Busoni and Cornelis Pot: see Knyt, “Between Composition and Transcription.”

99. See Key 1–4, notes 212–B.

100. Kittler, *Gramophone, Film, Typewriter*, 4. Pace Kittler, the predicament was not exclusively European: Charles Ives complained that once an idea had been written down, “it’s no good. Why when I see the notes I write down on the page and think of what I wanted it to sound like—why—It’s dead! It’s lousy with maggots!” Quoted in Budiansky, *Mad Music*, 13–14.

101. Quoted and translated in Grayson, “The Opera,” 35.

102. Prévost, *Sténographie musicale*; Stains, *Phonography*; and Baumgartner, *Kurz gefasste Anleitung zur musikalischen Stenographie oder Tonzeichenkunst*. On these methods,

see Cramer, “Of Serpentina and Stenography”; and Pierce, ““To Write with the Rapidity of Inspiration.”” As Patrick Feaster notes, the genealogy of such techniques can be traced back to 1775, when Joshua Steele attempted to register the “melody and measure” of theatrical speech via curved lines overlaid onto the lattice of the musical staff (*Pictures of Sound*, 131–33). In its attempt to delineate rather than to quantize vocal contours, Steele’s transcriptive notation anticipates analogous descriptive methods devised by Scott de Martinville and Louis Köhler, as discussed by Trippett (*Wagner’s Melodies*, 260–64), and even the prescriptive technique of *Sprechstimme* as deployed by Schoenberg.

103. See Feaster, “Édouard-Léon Scott de Martinville: An Annotated Discography”; Hankins and Silverman, *Instruments and the Imagination*, 133–37; and Trippett, *Wagner’s Melodies*, 256–60.

104. “L’écriture ou sténographie naturelle, dont voici les premiers rudiments, en rend le rythme, l’expression: elle est fonction de la tonalité, de l’intensité, du timbre, de la mesure. A ce titre elle est appelée à jouer dans les relations de la vie intellectuelle un rôle nouveau et imprévu; elle sera la parole vivante; notre calligraphie à la main ou imprimée n’est que la parole morte.” Scott de Martinville, *Phonautographic Manuscripts*, 44.

105. See Key 2–1, note 45.

106. See Sterne, *The Audible Past*, 45–46.

107. The implications of this distinction are pursued in Key 5. On the sixteenth-century *Salzburger Stier*, see Key 1–4, note 213; and Key 1–5, note 267. For perspectives on the phonograph’s indexical inscriptions, see Levin, “For the Record”; Ernst, *Digital Memory and the Archive*, 64–67 and 177–81; Rotman, *Becoming beside Ourselves*, 42; Cox, “Beyond Representation and Signification,” 153–55; and Butler, *The Ancient Phonograph*, 56–57 and 122–3.

108. Kittler, “The World of the Symbolic—A World of the Machine,” 139–40; see also Wilden, *System and Structure*, 162–63. The Lacanian corollary is that the dialectic between presence and absence so characteristic of analog recordings operates on the imaginary rather than the symbolic plane. On Lacan’s interpretation of the ludic and psychoanalytical implications of digital plenitude/lack as theorized by Freud, see Wilden, *System and Structure*, 145–52; on noise-reduction techniques and their problematization of Kittler’s Lacanian distinction between the digital/symbolic and the analog/real, see Kromhout, “A Soft Landing into a Bed of Noise.”

109. See Ashby, *Absolute Music, Mechanical Reproduction*, 137–40.

110. Sterne, “The Death and Life of Digital Audio,” 340–45; see also Rothenbuhler and Peters, “Defining Phonography.” Descola frames the phenomenon in the broader context of analogy as an anthropological schema, “a hermeneutic dream of plenitude that arises out of a sense of dissatisfaction.” Descola, *Beyond Nature and Culture*, 202.

111. On the intellectual history of this process, see Veit Erlmann’s discussion of the terms *gradation* and *progression* (*Reason and Resonance*, 120–22).

112. See, for instance, Abbate, “Outside Ravel’s Tomb”; Dolan, “E.T.A. Hoffmann and the Ethereal Technologies of ‘Nature Music’”; Hirt, *When Machines Play Chopin*; Jackson, *Harmonious Triads*, 75–110; Kang, *Sublime Dreams of Living Machines*, 185–222; Riley, “Composing for the Machine”; Riskin, “The Defecating Duck”; and Voskuhl, *Androids in the Enlightenment*.

1B. “Eben darum ist mir gerade die nach mechanischen Begriffen vollkommenste Maschine der Art eben die verächtlichste, und eine einfache Drehorgel, die im Mechanischen

nur das Mechanische bezweckt, immer noch lieber als der Vaucansonsche Flötenbläser." Hoffmann, "Die Automate," 17. Jackson aligns Ludwig's and Hegel's analogous sentiments in *Harmonious Triads*, 80–81; see also Adorno, "Drehorgel-Stücke," 39. As Voskuhl (*Androids in the Enlightenment*, 15–21) and Riley ("Composing for the Machine," 367–68) contend, the anxiety surrounding such automata is far more a phenomenon of the nineteenth century than the eighteenth.

14. On such players, games, and music, see Key 5–1, note 45; and Key 5–2, note 79.

15. Hoffmann's imagination was not merely fantastical, but promiscuously inter- and metatextual: Werner Keil points out that for those who encountered the abridged version of "Die Automate" published in the *Allgemeine musikalische Zeitung*, Ludwig would have been familiar from Hoffmann's essay "Der Dichter und der Komponist," which had appeared there a few weeks beforehand ("The Voice from the Hereafter," 145).

16. "Anselmus wunderte sich nicht wenig über die seltsam verschlungenen Zeichen, und bei dem Anblick der vielen Pünctchen, Striche und leichten Züge und Schnörkel, die bald Pflanzen, bald Moose, bald Thie gestalten darzustellen schienen, wollte ihm beinahe der Muth sinken, alles so genau nachmalen zu können." Hoffmann, *Der goldene Topf*, 2:176. Hoffmann pursued a similar conceit at the conclusion of *Kreisleriana*: "mysterious mosses and herbs" on an "infatuating rock" form "intriguing patterns" that somehow record the "beautiful song that my father sang almost every day." Hoffmann, "Johannes Kreisler's Certificate of Apprenticeship," 190.

17. See Cramer, "Of Serpentina and Stenography"; Charlton, *E.T.A. Hoffmann's Musical Writings*, 74; and Dolan, "E.T.A. Hoffmann and the Ethereal Technologies of 'Nature Music,'" 19–25.

18. See Levin, "For the Record," 36–42. In this regard, Edison's technological breakthrough marks the culmination of scientific and physiological experimentation across the intersecting fields of electricity and magnetism, the supernatural overtones of which permeate *Der goldene Topf* (witness, for instance, the sparks of electricity on pp. 89, 126, 166, and 178). On this Romantic genealogy, in which the chemist, physicist, and philosopher Johann Wilhelm Ritter plays a central role alongside Chladni, see Hankins and Silverman, *Instruments and the Imagination*, 128–32; Erlmann, *Reason and Resonance*, 188–202; and Strässle, "'Das Hören ist ein Sehen von und durch innen.'" On the spiritual, ghostly, and phantasmagorical aspects of nineteenth-century media writ large, see Andriopoulos, *Ghostly Apparitions*; Sconce, *Haunted Media*; and Tresch, *The Romantic Machine*, 125–87.

19. "Vollkommenheit des Fortepianos.—Nur Schönheit der Harmonie, nicht des Tons.—Es muß anscheinende Willkür herrschen, und je mehr sich die höchste Künstlichkeit dahinter versteckt, desto vollkommener." Quoted in Keil, "The Voice from the Hereafter," 144; see also Hoffmann's comments on Beethoven's writing for the fortepiano ("Review [of Beethoven's Piano Trios op. 70]," 149–50).

20. Ifrah, *The Universal History of Computing*, 176–77. On the complex "life mechanism" of *la musicienne*, which operates via lengthy routines that run independently of her musical programming in order to animate her performances, see Voskuhl, *Androids in the Enlightenment*, 140–45.

21. See Ifrah, *The Universal History of Computing*, 252–53.

22. Jevons, "On the Mechanical Performance of Logical Inference (Abstract)," 168; see also Buck and Hunka, "W. Stanley Jevons, Allan Marquand, and the Origins of Digital

Computing”; and Nierhaus, *Algorithmic Composition*, 44–45. In the context of his “piano,” Jevons’s invocation of the term *organon* is telling insofar as it is etymologically connected to the constitution and study of musical instruments as well as to Aristotle’s, Bacon’s, and Leibniz’s systematizations of logic.

123. Jevons, “On the Mechanical Performance of Logical Inference,” 504f. As Ifrah observes, the truth table of the logical conjunction “AND” is identical to the table of binary multiplication (*The Universal History of Computing*, 94).

124. Günther, “Cybernetic Ontology and Transjunctional Operations” (see also the discussion in von Foerster, *The Beginning of Heaven and Earth Has No Name*, 51–52 and 71–72); Wilden, *System and Structure*, 188.

125. Luhmann, *Art as a Social System*, 187. For Wilden, analog “negation,” conversely, “is many-valued. . . . Analog refusal, rejection, and disavowal are to be distinguished from syntactic negation.” Wilden, *System and Structure*, 188.

126. Kittler, *Gramophone, Film, Typewriter*, 18–9.

127. In Kittler’s words, “the media age proceeds in jerks, just like Turing’s paper strip.” *Ibid.*, 18.

128. In light of this transformation, Žižek found it necessary to reconfigure the real recursively, subjecting it to further tripartition in order to safeguard its Lacanian function while acknowledging its infiltration by the symbolic discourses and imaginary technologies associated with computation (*On Belief*, 82).

129. As Krämer puts it, Fourier “[accomplished] for the material realm of signals what the Greek alphabet achieved for the symbolic realm of language.” Krämer, “The Cultural Techniques of Time Axis Manipulation,” 101. Building on work by Euler, Fourier enabled their incalculability of irrational numbers to factor into calculations translating functions of time into functions of frequency, making their relations available for manipulation and technological transfer via numerical means. See also Siegert, “Mineral Sound or Missing Fundamental”; Ernst, *Digital Memory and the Archive*, 62–64; and Kromhout, “A Soft Landing into a Bed of Noise.”

130. Translating Babbage’s computational lexicon into contemporary terminology, the “mill” is analogous to the CPU while the “store” represents certain functions of random-access memory (RAM): see Dasgupta, *It Began with Babbage*, 18–22. For historical perspectives on the cultural and economic implications of the definition and division of computational labor in terms of Babbage’s industrial analogies, see Otis, *Networking*, 29–41; and Wise, “The Gender of Automata in Victorian Britain,” 167–76.

131. In addition to *Gramophone, Film, Typewriter*, see Kittler, “There Is No Software.”

132. On the young Turing’s imaginary typewriter, see Turing, *Alan M. Turing*, 19; on his fascination with his mother Sara’s typewriter and for a description of Turing’s universal machine as an “idealized typewriter,” see Soare, “Turing and the Discovery of Computability,” 470. Lydia H. Liu also addresses these parallels in *The Freudian Robot*, 55–57.

133. On the musical—and specifically pianistic—genealogy of House’s and Hughes’s telegraphs, see Zielinski, *Deep Time of the Media*, 183–91; Raykoff, *Dreams of Love*, 24–25; and van Rij, “A Living, Fleshy Bond,” 145–47.

134. Anonymous, “David E. Hughes.” Ivor Hughes and David Ellis Evans cast doubt on the veracity of this report (*Before We Went Wireless*, 345n6). In any case, the vision recorded by its author was eventually realized by Carpentier (see Key 1–4, note 212), whose electromagnetic “melograph” drew on Hughes’s telegraphic advancements.

135. On Debain's antiphonel, see Brauers, *Von der Äolsharfe zum Digitalspieler*, 51–52 and 204; Haspels, *Automatic Musical Instruments*, 87n59; Rimbault, *The Pianoforte*, 207; and Szendy, *Listen*, 74–76.

136. On this media-genealogical lineage, see Jürgen Hocker, *Faszination Player Piano*, 32–47; and Key 1–4, notes 236–40.

137. Feaster, “Speech Acoustics and the Keyboard Telephone.”

138. See Key 2–2, note 129; and Key 2–5, note 234.

139. In this regard, the functions of *la musicienne's* “brain” as well as her digits can be rationalized by von Neumann's observation that the computational functionality of a neural network as schematically represented by Warren S. McCulloch and Walter Pitts in 1943 is effectively Turing-complete (*The Computer and the Brain*, 66–76; see also the discussion in von Foerster, *The Beginning of Heaven and Earth Has No Name*, 20 and 37–38).

140. Jevons, “On the Mechanical Performance of Logical Inference (Abstract),” 168; see also Jevons, *Letters and Journal of W. Stanley Jevons*, 213, 241, and 249.

141. See Key 5–5, note 172.

2-3 INTERFACE VALUES

142. On these vexed interdisciplinary relations, see Dawe, “People, Objects, Meaning”; Irving, “Comparative Organography in Early Modern Empires”; Bijsterveld and Frank Peters, “Composing Claims on Musical Instrument Development”; and Bates, “The Social Life of Musical Instruments.”

143. As an experimental instrument, Václav Prokop Diviš's *Denis d'or* can be considered alongside both the electrical trials to which Ritter subjected himself, described by Erlmann (*Reason and Resonance*, 190–202), and, in a more public context, the eighteenth-century “electrical performances” addressed by Ciara Murphy (“Shocks and Sparks”). The flux and polarities of electrical phenomena gave rise to interpretations by Ritter that can be construed in analogical and digital terms, respectively. On the keyboard's relationship to sound synthesis as variously conceived and constructed by Thaddeus Cahill, Jörg Mager, Robert Moog, and Don Buchla, see Patteson, *Instruments for New Music*, 63–81; Pinch and Trocco, *Analog Days*, 42–45 and 58–62; and Théberge, *Any Sound You Can Imagine*, 52.

144. Dolan, “Toward a Musicology of Interfaces”; Dolan and Tresch, “Toward a New Organology,” 255–58.

145. See Scherer, “Klaviaturen, Visible Speech und Phonographie,” 38–39. For an illustration of the mental and physical disorientation that can ensue when such mappings need to be rewired, see Tom Beghin's account of coming to terms with the short octave of a mid-eighteenth-century harpsichord (*The Virtual Haydn*, 82–125).

146. On how such ecologies can be registered as assemblages of human and nonhuman forces, see Bennett, *Vibrant Matter*; see also Key 5–5, note 173.

147. See McGeary, “Harpsichord Mottoes.”

148. Cited in *ibid.*, 23. *Noli me tangere* has scriptural resonances: by casting the virginals as Christ himself, the motto plays on the ambiguity of the divine body. As part of the longer riddle *viva fui in sylvis, sum dura occisa securi, / dum vixi, tacui, mortua dulce cano* (“I was alive in the woods, but I was cut down by the hard axe. / While I lived I was silent; now that

I am dead, I sing sweetly”), this motto has been associated with musical instruments—and, by implication, with Apollo—since the Renaissance: see Borthwick, “The Riddle of the Tortoise and the Lyre,” esp. 379–80, whence this translation is drawn.

149. Harpsichord mottoes imply that this type of chiastic mediation is not restricted to the domain of the living, in line with Nonnus’s description of how the wind envoiced Marsyas’s hanging hide (*Dionysiaca* 19.321–22). Tellingly, as Richard Leppert notes, two paintings designed to adorn sixteenth-century harpsichord lids depict Apollo vs. Marsyas (“Music, Violence, and the Stakes of Listening,” 65n46).

150. Ernst, *Digital Memory and the Archive*, 147–52.

151. Such tablature notated music via alphanumeric symbols distributed across staff like grids or tables that could be deciphered with the aid of illustrations mapping those symbols onto keys, strings, or frets, as in Gonçalo de Baena’s *Arte novamente inventada para aprender a tanger* (1540) and Luys Venegas de Henestrosa’s *Libro de cifra nueva para tecla, harpa, y vihuela* (1557). I am grateful to Carlos Ramírez for bringing Baena’s treatise to my attention. On analogous systems devised by Juan Bermudo and Antonio de Cabezón, see Gouk, *Music, Science and Natural Magic in Seventeenth-Century England*, 131–33. On Parran’s and Rousseau’s systems of numerical notation, published in 1639 and 1742, respectively, see Parran, *Traité de la musique théorique et pratique*, 74–79; and Rousseau, *Project concerning New Symbols for Music*. For examples of the five-finger exercise, see Anton Diabelli’s *Melodische Uebungsstücke*, op. 149, and the *Fingerklavier* conceived by the renowned pedagogue Friedrich Fröbel (1844), discussed in Scherer, *Klavier-Spiele*, 137–40.

152. On the relationship between the *basse fondamentale* and the *basse continue*, see Christensen, “Thoroughbass as Music Theory,” 20–28; and Christensen, *Rameau and Musical Thought in the Enlightenment*, esp. 103–9. See also Holtmeier, “Heinichen, Rameau, and the Italian Thoroughbass Tradition,” 12–B.

153. Fétis, *Esquisse de l’histoire de l’harmonie*, 47 (see also Caffio, “The Early Reception of Neapolitan Partimento Theory in France,” 148–54); Gjerdingen, “A Source of Pasquini Partimenti in Naples,” 185–87; and Giorgio Sanguinetti, *The Art of Partimento*, 12.

154. Gjerdingen, *Music in the Galant Style*, 465–80; Gjerdingen, “Partimento, que me veux-tu?”; and Sanguinetti, *The Art of Partimento*. See also Moelants, *Partimento and Continuo Playing in Theory and in Practice*; and Holtmeier, Menke, and Diergarten, *Praxis und Theorie des Partimentospiels*.

155. On how the concept of wetware reverberates between the eighteenth and late twentieth centuries, see Prelude, note 7.

156. Diergarten characterizes the stenographic tradition from which *partimenti* emerged as “a kind of game and esoteric science for encoding polyphonic compositions into a single bass line.” Diergarten, “Beyond ‘Harmony,’” 59. For his part, Edoardo Bellotti describes Adriano Banchieri’s *Lorgano suonarino* (1605), the earliest known anthology of *partimenti*, as a collection of “musical seed[s] . . . from which polyphony can blossom.” Bellotti, “Counterpoint and Improvisation in Italian Sources from Gabrieli to Pasquini,” 51. Striking a similar tone, Francesco Geminiani asserted in his *Supplement to the “Guida armonica”* (1757, discussed in Key 3–1) “that the Notes of the Bass . . . include Harmony, Modulation and Melody”; both J.S. and C.P.E. Bach expressed analogous thoughts, as Vasili Byros points out (“Prelude on a Partimento,” [2.6]). Sanguinetti observes that *maestri di partimenti* described the motion of voice leading in terms of movement of the hands at the keyboard rather than

“abstract voices” (*The Art of Partimento*, 104). On the broader relations and distinctions between the “verticality” of harmony and the “linearity” of counterpoint in the theory and practice of thoroughbass, see Holtmeier, “Heinichen, Rameau, and the Italian Thoroughbass Tradition,” 8–9.

157. See Gjerdingen, “*Partimenti* Written to Impart a Knowledge of Counterpoint and Composition”; and Sanguinetti, “*Partimento*-Fugue: The Neapolitan Angle.”

158. See Guido, “Counterpoint in the Fingers,” 69–72; and Holtmeier, “Heinichen, Rameau, and the Italian Thoroughbass Tradition,” 28–31.

159. “Musica est exercitium arithmeticae occultum nescientis se numerare animi.” Leibniz to Christian Goldbach, April 17, 1712, in *Viri illustris Godefridi Guiljelmi Leibnitii epistolae*, 1:241. In a similar vein, Sanguinetti describes the process of realizing *partimenti* as a form of “automatic composition” (*The Art of Partimento*, 6).

160. Locke, *An Essay concerning Human Understanding*, 281; see Raz, “Reverberating Nerves.” On Condillac and Diderot, see Thomas, “Competing Models of Sensibility in Condillac,” 154–55; and Christensen, “Bemetzrieder’s Dream,” 49, respectively; see also Davies, *Romantic Anatomies of Performance*, 55–57. On Gadamer’s formulation of play, see Prelude, note 6.

161. It is in this sense that the “instruments” clustered on a car’s dashboard operate as such. I am grateful to Brian Hanrahan for drawing this point to my attention.

162. “Das Clavichord ist also das Instrument, worauf man einen Clavieristen aufs genaueste zu beurtheilen fähig ist.” Bach, *Versuch über die wahre Art das Clavier zu spielen*, 1:12.

163. In this regard, the clavichord might be thought of as a musical antecedent to nineteenth-century sphygmographs, which oscillographically inscribed a patient’s pulse on a glass plate: see Hankins and Silverman, *Instruments and the Imagination*, 137–38. The techniques of *Bebung* and *Tragen der Töne* were briefly described by Bach (*Versuch über die wahre Art das Clavier zu spielen*, 1:50); see also Scherer, *Klavier-Spiele*, 63–70. On *Schnellen*, see Delft, “Schnellen.” On sentiment, melancholy, fantasy, and femininity as mediated by the clavichord, see Richards, *The Free Fantasia and the Musical Picturesque*, 145–82.

164. Burney, *Dr. Burney’s Musical Tours in Europe*, 2:219.

165. Bach concluded his autobiography, written in 1773, by drawing attention to his efforts “towards both playing and composing as songfully as possible for the clavier [clavichord], notwithstanding its lack of sustaining power.” Quoted and translated in Newman, “Emanuel Bach’s Autobiography,” 372. On the relationship between voice and clavichord from a range of perspectives, including the technological and the psychoanalytical, see also Scherer, *Klavier-Spiele*, 43–106; Scherer, “Die Stimme und das Clavichord”; Richards, *The Free Fantasia and the Musical Picturesque*, 151–55; and Siegert, *Passage des Digitalen*, 265–66.

166. Dolmetsch, *The Interpretation of the Music of the XVIIth and XVIIIth Centuries Revealed by Contemporary Evidence*, 433.

167. Ernst Wilhelm Wolf, “Vorbericht (als eine Anleitung zum guten Vortrag beym Clavierspielen),” quoted and translated in Hogwood, “A Supplement to C.P.E. Bach’s *Versuch*,” 146.

168. “Aus der Seele muß man spielen, und nicht wie ein abgerichteter Vogel.” Bach, *Versuch über die wahre Art das Clavier zu spielen*, 1:42. As Siegert phrases it, “Damit bleibt über dem Clavichord-Spiel [*sic*] der Kantische Imperativ errichtet, daß ein *Ich denke* alle meine Bewegungen muß begleiten können.” Siegert, *Passage des Digitalen*, 266.

169. “Wenn also zuerst die bestimmte Natur und angebohrne Eigenthümlichkeit des Individuums zusammen mit dem, was sie durch die Bildung geworden, als das Innere, als das Wesen des Handelns und des Schicksals genommen wird, so hat es seine Erscheinung und Aeusserlichkeit zuerst an seinem Munde, Hand, Stimme, Handschrift so wie an den übrigen Organen, und deren bleibenden Bestimmtheiten; und alsdann erst drückt es sich weiter hinaus noch aussen an seiner Wirklichkeit in der Welt aus.” Hegel, *Die Phänomenologie des Geistes*, 251; translation in *Phenomenology of Spirit*, 189–90.

170. In musical terms, Nägeli articulated this Romantic relocation of the keyboard’s function in relation to the spirit that animated it: “So ist ganz gewiß die Mehrzahl der Kunstwerke nicht bloß am Klavier, sondern vermittelt des Klavierspiels erfunden, so zu sagen, aus dem Geiste herausgefunden.” Nägeli, *Vorlesungen über Musik*, 121; see also Scherer, *Klavier-Spiele*, 52–61 and 167.

171. Wolf’s literary account of a fantasia he published in 1785, for instance, goes into considerable emotive and technical detail: see Hogwood, “The Clavier Speaks,” 362–64.

172. Richard Kramer, “Probing the *Versuch*,” 92: perhaps unsurprisingly, Heinrich Schenker subjected the fantasia and its *Gerippe* (or *Plan*, as he referred to it) to approbatory analysis (“The Art of Improvisation,” 8–13). See also Richards, *The Free Fantasia and the Musical Picturesque*, 42; Levin, “Mozart’s Non-Metrical Keyboard Preludes,” 198–200; and Caporaletti, “Ghost Notes,” 366–70. I am grateful to Jonathan Schakel for pointing out the different technical means by which the *Gerippe* and the fantasia were printed.

173. Burney, *Dr. Burney’s Musical Tours in Europe*, 2:219; see also Richards, *The Free Fantasia and the Musical Picturesque*, 56–59.

174. On the boundary between genius and madness as drawn by Burney with reference to Bach, see Richards, *The Free Fantasia and the Musical Picturesque*, 48–49. In this context, it is telling that Bach strongly expressed a preference for figured bass lines over their unfigured counterparts (*Versuch über die wahre Art das Clavier zu spielen*, 2:297), and that, despite its free-form associations, the genre of the fantasia was grounded in the detailed “knowledge of modulations, counterpoint, and fugue,” as Banchieri put it in 1609 (quoted in Guido, “Counterpoint in the Fingers,” 65). On the centrality of figured bass lines to the specific types of modulatory strategy pursued in Bach’s fantasias, see Head, “Fantasia and Sensibility,” 261.

175. Vogler upbraided Bach for his love of “forced artificiality,” finding it necessary to remind him that “between *musikalischer Fantasie* and a high fever, there is a world of difference.” Quoted and translated in Richards, *The Free Fantasia and the Musical Picturesque*, 35.

176. Rochlitz, “Der Besuch im Irrenhause”: see Richards, *The Free Fantasia and the Musical Picturesque*, 145–48; and Hamilton, *Music, Madness, and the Unworking of Language*, 177–79. As Hamilton points out, Hoffmann acknowledged Rochlitz’s account of Karl as inspiration for his own Ritter Gluck: see Key 4–5, note 255.

177. See Richards, *The Free Fantasia and the Musical Picturesque*, 56–59.

178. “Alle unanständigen Mienen, Verzuckungen, Grimassen . . . muß man dem Lernenden . . . gleich anfangs nicht zulassen. Hier ist Artigkeit und Nachsicht gegen ein Frauenzimmer sehr tadelhaft” Türk, *Klavierschule*, 23; translation in *School of Clavier Playing*, 30.

179. “Le clavier, c’est l’alphabet; les touches, ce sont les lettres. Avec ces lettres, on forme des syllabes; avec ces syllabes, des mots, avec ces mots, des phrases; avec ces phrases, un discours.” Diderot, *Leçons de clavecin et principes d’harmonie*, 520–21. On the question of how authorship was distributed between Diderot and Bemetzrieder, see Jerold, “Diderot [Part

I].” Diderot’s and Bemetzrieder’s musical poetics can be set alongside Mattheson’s *locus notationis*, which draws parallels between notes and letters as elements to be concatenated and permuted in various ways (*Der vollkommene Capellmeister*, 124). Both also accord with August Wilhelm Schlegel’s definition of poetry, which drew on Hellenistic models: “The first poem consists of nothing but verses; the verse of words; the words of syllables; the syllables of single sounds.” Schlegel, *Kritische Schriften und Briefe*, 1:41, translated in Kittler, *Discourse Networks, 1800/1900*, 43. Angélique’s *prélude*, attributed to the anonymous *élève*, is also reproduced in Diderot, *Leçons de clavecin* (303–6). On the relationship between Diderot and Bach, see Lietz, “Le passage de Diderot par l’Allemagne en 1774”; and Kramer, “Diderot’s *Paradoxe* and C.P.E. Bach’s *Empfindungen*.”

180. The Mozart concerto performed by Paradis may well have been K. 456 in B flat. Kempelen’s *Handdruckpresse* is mentioned by Gabriel Farrell, who described it as “perhaps the first machine that proved to be adequate for practical use” (*The Story of Blindness*, 120): see also Beeching, *Century of the Typewriter*, 7. Vogler developed an analogous system designed to enable Paradis to notate music (see Fürst, *Maria Theresia Paradis*, 33–35 and 107–9), indicating that his pedagogical methods aligned with Diderot’s and/or Bemetzrieder’s hierarchical organization of musical elements as discrete symbols.

181. See Diderot, *Lettre sur les aveugles* and *Lettre sur les sourds et muets*. A wax bust of Paradis, among the holdings of the Wien Museum since 1943 but previously at the Linz School for the Blind, was made so that students could come to know her likeness via touch.

182. See Hankins and Silverman, *Instruments of the Imagination*, 176–216; Giannini, “The Two Heads of the Abbé”; Zielinski, *Deep Time of the Media*, 190; Kursell, “Experiments on Tone Color in Music and Acoustics,” 203–6; and Key 2–2, note 137. I am grateful to Aya Saiki for bringing Mical’s invention to my attention.

183. See Key 1–4, note 236. Braille’s code was itself derived from a sonographic code invented by artillery captain Charles Barbier de la Serre for the purposes of silent nocturnal military communication: see Jean Roblin, *Les doigts qui lisent*, 57–68.

184. Weissmann, *Music Come to Earth*, 4. Such prejudice was deep-rooted: discussing the role played by the clavichord in eighteenth-century German love poetry and songs, typically performed by women, Annette Richards shows the instrument to have been “a sonic mirror of the sufferer’s psyche” that could nonetheless “find its true voice only at the hands of the male *Originalgenie*, most particularly in his improvisations.” Richards, *The Free Fantasia and the Musical Picturesque*, 156 and 171; see also Head, *Sovereign Feminine*, 48–83.

185. Raykoff, *Dreams of Love*, 24–40; Kittler, *Gramophone, Film, Typewriter*, 194–95. Such gendered readings can be traced back to 1888: “The type-writer is especially adapted to feminine fingers. They seem to be made for type-writing. The type-writing involves no hard labour, and no more skill than playing the piano.” Harrison, *Manual of the Type-Writer*, 9. See also Scherer, *Klavier-Spiele*, 197–200; Dolan, “Toward a Musicology of Interfaces”; Dolan and Tresch, “Toward a New Organology,” 287–88; and Davies, *Romantic Anatomies of Performance*, 19–22.

186. On the industrialization of pedagogical methods and devices, see Blasius, “The Mechanics of Sensation and the Construction of the Romantic Musical Experience”; Parakilas et al., *Piano Roles*, 15–19; Loesser, *Men, Women and Pianos*, 293–301; and Scherer, *Klavier-Spiele*, 107–223.

187 On the piano's technological entanglements, see Carew, *The Mechanical Muse*; Loesser, *Men, Women and Pianos*; Parakilas et al., *Piano Roles*; Roell, *The Piano in America, 1890–1940*; Théberge, *Any Sound You Can Imagine*, 24–27; Weber, *Die rationalen und soziologischen Grundlagen der Musik*, 90–95; Daub, *Four-Handed Monsters*, 163–85; and Libin, “Progress, Adaptation, and the Evolution of Musical Instruments,” 204.

188. Adolf Weissmann diagnosed the dialectics of this nineteenth-century condition from the postlapsarian vantage point of 1926, drawing attention to the conflicting yet mutually dependent impulses to “[endow] the machine with a soul” and to “debase the instrument to a real mechanism” via the keys of the (player) piano: both the “highest creative achievement and the lowest form of counterfeit are within the range of the keyboard.” Weissmann, *Music Come to Earth*, 5 and 37. As Voskuhl points out, the “mass-production of bourgeois selves” took place via mechanical methods of selection and cultivation that are both contiguous with and remote from the bespoke craftsmanship of eighteenth-century artisanal boutiques such as the Jaquet-Droz workshop (*Androids in the Enlightenment*, 229–30; see also Foucault, *Society Must Be Defended*, 179–82).

189. From this perspective, the history of piano “preparation” and the development of extended techniques at the instrument, of which Henry Cowell was an early proponent and Cage the most famous exponent, might be considered in terms of other hardware modifications that circumvent restrictions imposed by material and legal conventions, prohibitions, and taboos.

190. Anonymous, “Annonces motivées,” 107; see Weitz, “Monochromatic and ‘Polychromatic’ Performance.”

191. Anonymous, “De l'étude (3e article),” 151.

192. “[A transcription for piano] bears the same relation to an orchestral work that an engraving bears to a painting; it multiplies the original and makes it available to everyone, and even if it does not reproduce the colors, it at least reproduces the light and shadow.” Liszt, *An Artist's Journey*, 45; see also Hoffmann, “Review [of Beethoven's Piano Trios op. 70],” 150; Christensen, “Four-Hand Piano Transcription and Geographies of Nineteenth-Century Musical Reception,” esp. 274–82; and Daub, *Four-Handed Monsters*, 76–81. On the multifarious ways that Liszt's transcriptions manipulate the piano's signal-to-noise ratio in order to channel the idealized content of the original works by way of materials and techniques that depart from the letter of the score, see Gooley, “Stormy Weather.”

193. On Jaëll, see Kursell, “Visualizing Piano Playing, 1890–1930”; and Davies, *Romantic Anatomies of Performance*, 165–67. In the acoustical tradition established by Helmholtz, Ludwig Riemann conducted a more systematic investigation into pianistic touch and its sonorous effects (*Das Wesen des Klavierklanges und seine Beziehungen zum Anschlag*).

194. In his rules for practicing the piano, Busoni advised students to “take it for granted from the beginning that everything is possible on the piano, even where it seems impossible to you and even when it really is so.” Busoni, *The Essence of Music*, 81. On the performance of such musical “techniques of illusion” at the keyboard, see Robb, “Imagined, Supplemental Sound in Nineteenth-Century Piano Music.”

195. “Durchaus war es ihr wie ein Traum, zu denken, wer noch vor wenigen Stunden davor gesessen habe. Lang blickte sie gedankenvoll die Tasten an, die er zuletzt berührt, dann drückte sie leise den Deckel zu und zog den Schüssel ab, in eifersüchtiger Sorge, daß so bald keine andere Hand wieder öffne.” Mörike, *Mozart auf der Reise nach Prag*, 78; trans-

lation in *Mozart's Journey to Prague*, 82. Mörike's novella was written to commemorate the centenary of Mozart's birth.

196. In the cold light of 1926, Hans Heinz Stuckenschmidt could confidently dismiss the last vestiges of the illusions purveyed by Busoni and subjected to investigation by Jaëll (see notes 193-94 above): "Every expressive nuance that the pianist creates by the movement of the keys can also be achieved and captured by mechanical means." Quoted and translated in Patteson, *Instruments for New Music*, 34.

2-4 (KEY)BOARD GAMES AND TEMPERAMENTAL TACTICS

197. Bourdieu, "Sport and Social Class," 824: see also Key 1-4, note 273. Bourdieu proceeded to contrast the perceptions of sporting *Kenner* and *Liebhaber* in ludomusical terms: the connoisseur "finds in the promptness of a movement, in the unforeseeable inevitability of a successful combination or the near-miraculous orchestration of a team strategy, a pleasure no less intense and learned than the pleasure a music-lover derives from a particularly successful rendering of a favorite work." *Ibid.*, 829. Bourdieu's judgment reinforces the parallel drawn by Leonard B. Meyer between "the peculiar relationships discerned in a specific composition or the idiosyncratic play of a particular game. And just as our delight in the play of a particular game of football depends in crucial ways on our understanding of the constraints governing the game . . . , so our enjoyment and evaluation of art depends on our knowledge (which may be tacit) of the constraints that governed the choices made by the artist and, hence, the relationships presented in the work of art." Meyer, *The Spheres of Music*, 193.

198. Lévi-Strauss, *La pensée sauvage*, 46-47: see also McCormick, "Higher, Faster, Louder."

199. See Key 5-5, note 17A.

200. On the chekker, see (in chronological order) Ripin, "Towards an Identification of the Chekker"; Page, "The Myth of the Chekker"; Barry, "Henri Arnaut de Zwolle's *Clavicordium* and the Origin of the Chekker"; Meeùs, "The Chekker"; and Kinsela, "The Capture of the Chekker."

201. For the hypothesis that the keyboard was devised to avoid the need to slide the bridge of the monochord to produce each pitch, see Montagu, *The World of Medieval and Renaissance Musical Instruments*, 54-56. On the origins of the clavichord more generally, see Brauchli, *The Clavichord*, 8-20. While acknowledging the historical role played by the keyed monochord, Brauchli is careful to treat it and the clavichord as instruments with entwined histories that are nonetheless distinguishable (*ibid.*, 41-42).

202. Meeùs, "The Chekker," 9. The subtitle to Mersenne's *Harmonicorum libri* (1635-36), the volumes in which he described a keyboard as an abacus, makes this point clear: although ostensibly about harmony, these books will be "useful for grammarians, orators, philosophers, legal advisors, physicians, mathematicians and theologians." Quoted and translated in Knobloch, "*Musurgia Universalis*," 263: see also Dear, "Marin Mersenne."

203. Page, *The Christian West and Its Singers*, 458; Licht, *Algorithmus linealis cum pulchris conditionibus Regule detri*, cited and illustrated in Meeùs, "The Chekker," 11. For Licht, who studied and subsequently practiced as a *Reichenmeister* in Leipzig, the use of the abacus was as important to humanistic study as it was to merchants, just as Mersenne would stress the broad relevance of the study of harmony (see note 202 above). Karl Menninger suggested that the shift of the abacus's default orientation from the vertical to the horizon-

tal, thought to have occurred in the thirteenth century, betrayed the influence of the Guidonian staff, the development of which is associated with the iconic representation of strings (*Number Words and Number Symbols*, 340–41): see also Key 2–2, notes 80–81.

204. Helmholtz, “On the Physiological Causes of Harmony in Music,” 62.

205. In this context, it is telling that the Baudot-encoded transmissions of Lorenz *Schlüsselzusatz* cipher machines during the Second World War (see Key 1–4, note 238) relied on Boolean operations that were decrypted by British Colossus machines, arguably the first programmable digital computers: see B. Jack Copeland, “Tunny and Colossus”; and Dasgupta, *It Began with Babbage*, 77–79.

206. On the labyrinthine genealogy of *Doom*, see Angela Ndalianis, *Neo-Baroque Aesthetics and Contemporary Entertainment*, 96–107. Developed and published in 1993 by id Software, *Doom* was a highly influential FPS game. Throughout its lengthy heyday, multi-player *Doom* relied on the transmission of data packets over the internet by modems that operated according to Baudot’s multiplexing principles and whose performance was typically measured in the units named in his honor.

207. As Ernst puts it, “the equation of world and number in terms of musical harmonies turns musical instruments into analog computers of a kind that model laws of temporal order in the physical world.” Ernst, *Sonic Time Machines*, 26.

208. See Barbieri, *Enharmonic Instruments and Music*. From Doni’s revival of ancient Greek *genera* and *tonoi* to attempts to preserve the purity of Handelian sonorities in Victorian Britain, Barbieri’s comprehensive survey of enharmonic phenomena reveals that the same principles were deployed in the service of the historical imagination before they were turned to revolutionary causes by figures such as Julián Carrillo in Mexico and Harry Partch in the United States (on whose techniques see Madrid, *In Search of Julián Carrillo and “Sonido 13”*; and Partch, *Genesis of a Music*, respectively).

209. The keys of the Halberstadt organ’s “manuals,” illustrated in the appendix to the second volume of Michael Praetorius’s *Syntagma musicum* (*Theatrum instrumentorum seu sciagraphia*, 25), were two inches wide, a carillon-like spacing that possibly indicates that they were to be played with fists rather than fingers. Since the organ was rebuilt in the fifteenth century, this layout might not extend as far back as 1361.

210. See Barbieri, *Enharmonic Instruments and Music*, 441–505.

211. *Ibid.*, 463–66.

212. *Ibid.*, 100–102 and 345–51. In various aspects, White’s “harmon” reflects Robert Holford Macdowall Bosanquet’s “enharmonium” (1872–3) and Paul von Jankó’s isomorphic piano keyboard (1882) as well as Charles Wheatstone’s early designs for the interface of the English concertina (on which see Gawboy, “The Wheatstone Concertina and Symmetrical Arrangements of Tonal Space”). In consultation with Bosanquet, Helmholtz identified the harmonium as particularly suitable for enharmonic experimentation, comparing its output favorably with the “false and disturbing” sound of the piano. Helmholtz, *On the Sensations of Tone*, 323; see also Hui, *The Psychophysical Ear*, 55–87; Steege, *Helmholtz and the Modern Listener*, 206–14; and Hiebert, *The Helmholtz Legacy in Physiological Acoustics*, 59–77.

213. Tanaka, “Studien im Gebiete der reinen Stimmung”: see also Hiebert, *The Helmholtz Legacy in Physiological Acoustics*, 81–110. As Kittler wistfully observed, “the historical parallels between music and strategy remain to be drawn” (*The Truth of the Technological World*, 358n45). The *Kriegsspiel* was developed by Georg Leopold von Reiswitz in order to

train Prussian military commanders: on its history, see von Hilgers, *War Games*, 31–5; Perla, *The Art of Wargaming*; and Peterson, *Playing at the World*.

214. See Keislar, “History and Principles of Microtonal Keyboard Design.”

215. See, for instance, Pagnerre, *De la mauvaise influence du piano sur l’art musical*; Weber, *Die rationalen und soziologischen Grundlagen der Musik*, 78–80; Partch, *Genesis of a Music*, 373–74; Théberge, *Any Sound You Can Imagine*, 165–66; and, on MIDI, Lanier, *You Are Not a Gadget*, 7–14. As with the QWERTY keyboard, the longevity of the Halberstadt layout has given rise to speculation into the network effects that have sustained its ubiquity: see Marshall, “The Development of the Organ Keyboard,” 18–9, and Liebowitz and Margolis, “The Fable of the Keys.”

216. Quoted in Dolan, “Toward a Musicology of Interfaces,” 10; translation in MacDonald, *Berlioz’s Orchestration Treatise*, 39. See also Hindley, “Keyboards, Crankshafts and Communication,” 35. Elsewhere, Berlioz expanded on the same ludomusical analogy: “De cette façon, les exécutants reçoivent immédiatement et instantanément la communication du sentiment de celui qui les dirige, y obéissent aussi rapidement que font les marteaux d’un piano sous la main qui presse les touches, et le maître peut dire alors qu’il *joue de l’orchestre* en toute vérité.” Berlioz, *Les soirées de l’orchestre*, 324.

217. Quoted in Kostelanetz, *Conversing with Cage*, 102. For a toe-curling demonstration of the keyboard’s colonial implications, see William Watson’s Victorian poem “The Keyboard”: “Five-and-thirty black slaves, / Half-a-hundred white, / All their duty but to sing/ For their Queen’s delight, / Now with throats of thunder, / Now with dulcet lips, / While she rules them royally / With her finger-tips!” Watson, *The Poems of William Watson*, 1:72. I ruefully thank Carmel Raz for bringing this poem to my attention.

218. Bemetzrieder, quoted and translated in Jerold, “Diderot (Part I),” 49; Bemetzrieder, *Nouvelles leçons de clavecin*, 120n. Writing to Giovanni Battista Martini, André-Ernest-Modest Grétry praised Bemetzrieder’s “dozen pupils” capable of “entwining the twenty-four keys of music” and thereby “speak[ing] very eloquently.” Quoted and translated in Jerold, “Diderot [Part I],” 47; see also Jerold, “Diderot [Part II],” 72–73.

219. Diderot, *Leçons de clavecin*, 328–29; translation in Jerold, “Diderot (Part I),” 48.

220. Cohn, *Audacious Euphony*, 178.

221. *Ibid.*, 176. In line with Diderot and Bemetzrieder, Cohn points out that Andreas Werckmeister (1698), Vogler (1778), and Honoré de Langlé (1797) mapped out a twenty-four-triad cycle comprising alternating leading-tone and relative-minor/major transformations involving a single pitch, displaced by one or two semitones, respectively: as Carl Stein observed in 1888, the other two pitches “always [remain] undisturbed” (quoted and translated in *ibid.*, 92). Such “single-finger” transformations interleave hexatonic- and Weitzmann-group operations, as Cohn dubs them (*ibid.*, 90).

222. Bowles, “On the Origin of the Keyboard Mechanism in the Late Middle Ages.” For Bowles, all these elements are reflected in the earliest extant treatise on the construction of keyboard instruments, written by the physician and astronomer Henri Arnaut de Zwolle between ca. 1438 and 1446 (*ibid.*, 160–62). On the influential Islamic legacy of “finger technologies” associated with mechanization, automation, calculation, and decoration, see Nadarajan, “Islamic Automation.”

223. The relationship between European and Chinese formulations of equal temperament and the question of which should be granted historical precedence continue to stir

inquiry and debate. See, for instance, Kuttner, "Prince Chu Tsai-Yü's Life and Work"; Cho, *The Discovery of Musical Equal Temperament in China and Europe in the Sixteenth Century*, 147-226; and (on the establishment of twelve-note equal temperament in Europe) Barbieri, *Enharmonic Instruments and Music*, 279-98. Rather than attempting to disentangle the knotty question of who invented/discovered/formalized equal temperament first, here I merely register the fact that it formed a site at which both European and Chinese conceptions of music came into epistemological contact.

2-5 TRISTAN'S CHORD, SCHOENBERG'S VOICE

224. "Supposez au clavecin de la sensibilité et de la mémoire, et dites-moi s'il ne se répètera pas de lui-même les airs que vous aurez exécutés sur ses touches. Nous sommes des instruments doués de sensibilité et de mémoire. Nos sens sont autant de touches qui sont pincées par la nature qui nous environne, et qui se pincent souvent elles-mêmes." Diderot, "Entretien entre d'Alembert et Diderot," 114. On this passage, see Abbate, "Outside Ravel's Tomb," 475-82; Rex, *Diderot's Counterpoints*, 173-75; Christensen, "Bemetzrieder's Dream," 45-46; and Erlmann, *Reason and Resonance*, 118. On the lineage of the keyboard instrument as a metaphor for sensation, advanced by François Cartaud de la Vilate, Armand-Pierre Jacquin, Montesquieu, and Julien Offray de La Mettrie (among others), see Erlmann, *Reason and Resonance*, 116-20; and Thomas, "Competing Models of Sensibility in Condillac," 161 n16.

225. While Erlmann reads this recursion as articulating "an inexorable totality and completeness of organization that lends a hermetic closure to both the subject and the discourse about the subject" (*Reason and Resonance*, 118) it could also be understood as a radical expansion of both, especially in light of Diderot's observations on the unlikely imaginative leaps that constitute analogical thought, modeled on the sympathetic resonance of neighboring strings.

226. "[Nous] éprouvons des sensations à-peu-près comme un clavecin rend des sons." Condillac, *La logique*, 85. See also the commentary by Thomas ("Competing Models of Sensibility in Condillac," 155-58) and Christensen ("Bemetzrieder's Dream," 45-51), who stress the ludic and chiasmic elements of the analogy and its intertwining of the sensible and the material *chez* Condillac and Diderot, respectively.

227. "Die Musik spielt in uns ein Clavichord, das unsere eigene innigste Natur ist. . . . Nicht wir zählen und messen, sondern die Natur; das Clavichord in uns spielt und zählet." Herder, *Kalligone*, 703 and 705; see also 949. For commentary, see Dolan, *The Orchestral Revolution*, 46-47 and 85-87; and Scherer, "Die Stimme und das Clavichord," 285-86 and 288.

228. See Hamilton, *Music, Madness, and the Unworking of Language*, 84-85.

229. On the conflict between German vitalists and mechanists as played out musically in the eighteenth century, see Yearsley, *Bach and the Meanings of Counterpoint*, 173-208.

230. Dolan, *The Orchestral Revolution*, 73-79.

231. "Il y a un moment de délire où le clavecin sensible a pensé qu'il était le seul clavecin qu'il y eût au monde, et que toute l'harmonie de l'univers se passait en lui." Diderot, "Entretien entre d'Alembert et Diderot," 118. The delusions of Diderot's harpsichord stand in ironic contrast to the faith represented by Kircher's mighty "cosmic organ," the six registers of which allegorized the very creation of the universe (*Musurgia universalis*, 2:366).

232. Berlioz, *Les soirées de l'orchestre*, 240-44. It seems likely that Berlioz's narrative was informed by his distrust of devices such as Debain's antiphonal (see Macdonald, *Berlioz's*

Orchestration Treatise, 314; Szendy, *Listen*, 75; and Key 2–2, note 135) as well as a familiarity with Goethe’s famous poem “Der Zauberlehrling” (1797).

233. Müller, *Elements of Physiology*, 674.

234. Helmholtz, “On the Physiological Causes of Harmony in Music,” 83–84 and 104; see Scherer, *Klavier-Spiele*, 169–205; Erlmann, *Reason and Resonance*, 226–34; and Steege, *Helmholtz and the Modern Listener*, 63–67. Steege notes that Helmholtz’s digital analogy can be traced back to 1737, when Jean-Jacques Dortous de Mairan compared the organization of the basilar membrane to that of a harpsichord (*ibid.*, 63n39).

235. “Der moderne ‘Flügel’ ist es, dem *Helmholtz* den Schlüssel zu dem zweitausendjährigen, im innersten Verschluss des Ohres verborgenen Geheimniss abgelauscht hat.” Kapp, *Grundlinien einer Philosophie der Technik*, 86; see also Patteson, *Instruments for New Music*, 9 and 171n26.

236. See Key 2–3, note 159.

237. Steege, *Helmholtz and the Modern Listener*, 66.

238. “All die zahllosen Umwelten liefern . . . die Klaviatur, auf der die Natur ihre überzeitliche und überräumliche Bedeutungssymphonie spielt. Uns ist während unseres Lebens die Aufgabe zugewiesen, mit unserer Umwelt eine Taste in der riesenhaften Klaviatur zu bilden, über die eine unsichtbare Hand spielend hinübergleitet.” Uexküll, *Bedeutungslehre*, 159. As well as distantly echoing Kircher’s “cosmic organ” (see note 231 above), Uexküll’s keyboard resonates with Charles Fourier’s twelve-note “series,” expounded as a neo-Pythagorean theory of human, natural, and cosmic order whose combinatorial principles were illustrated by what Fourier dubbed the “general keyboard” of personality traits (*Le nouveau monde industriel et sociétaire*, 403–8).

239. Flusser, *The Shape of Things*, 89. In Till A. Heilmann’s formulation, the keystroke is now “the gesture of the digital, the fundamental cultural technique of our time.” Heilmann, “Digitalität als Taktilität,” 133.

240. Flusser, *The Shape of Things*, 92–93.

241. Derrida, “Structure, Sign, and Play in the Discourse of the Human Sciences,” 260. Derrida was presumably glossing Wilhelm von Humboldt’s codification of linguistic rules, as interpreted by Noam Chomsky (quoted and translated in Chomsky, *Aspects of the Theory of Syntax*, v).

242. See Kittler, *Gramophone, Film, Typewriter*, 247.

243. Carl Schmitt’s essay “Die Buribunken“ (1917) provides a satirical perspective on Hegelian bureaucrats whose typewritten diaries at once construct, disclose, and document their historical subjectivity: “I am thus a letter on the typewriter of history. . . . At each second of world history, the letters of the typewriter keyboard leap, impelled by the nimble fingers of the world-I, onto the white paper and continue the historical narrative.” Schmitt, quoted and translated in Kittler, *Gramophone, Film, Typewriter*, 241.

244. Flusser, *The Shape of Things*, 93. As Luhmann observed, and as the delirium of Diderot’s harpsichord betrays, recursion can serve to conceal “the inability of systems to ground their own legitimacy,” in Larson Powell’s words (“Excursions and Recursions,” 436).

245. Flusser’s father, mother, grandparents, and sister all died in German concentration camps during the Second World War. In this regard, Flusser’s ironic evocation of the keyboard stands in poignant contrast to Schmitt’s (see note 243 above), no matter how much else they might have in common.

246. See, for instance, Babbitt, “Twelve-Tone Invariants as Compositional Determinants.”

247. See, for instance, Lewin, “Some Applications of Communication Theory to the Study of Twelve-Tone Music”: on the intellectual context of this discourse, see Grant, *Serial Music, Serial Aesthetics*.

248. See Meyer-Eppler, “Statistische und psychologische Klangprobleme”; and Brecht, *Notebooks I, II, II*, 3: 120. Meyer-Eppler’s blending of acoustics, synthesis, and information theory had a considerable impact on postwar European music in general and on Stockhausen’s compositional technique in particular. The overtly ludic implications of Josef Hauer’s *Zwölfte spiele*, many of which draw as much on the principles of indeterminacy as on “serial” techniques, reveal that the same concepts and procedures could freely cross aesthetic battle lines.

249. Today, fantasy sports leagues are perhaps the most socially prominent instance of such recursive metaplay and its reliance on digital abstraction.

250. Perich’s keyboard works include *Dual Synthesis* for harpsichord and 4-channel 1-bit electronics (2009) and *Surface Image* for piano and 40-channel 1-bit electronics (2013).

251. See Leibniz, *Nouveaux essais sur l’entendement humain*, 17; and Leibniz, *La monadologie*. Erlmann offers an illuminating perspective on this aspect of Leibniz’s thought in relation to Helmholtz and nineteenth-century otology (*Reason and Resonance*, 243–46).

252. Leibniz, *Die philosophischen Schriften*, 5:48; see also Cox, “Sound Art and the Sonic Unconscious,” which explores how Leibniz’s sonic observations have provided epistemological foundations for contemporary sound art as a distinct category of aesthetic experience. The output of Perich’s fifteen hundred speakers might also be heard as a response to the schoolteacher and organist Hamann in Julius Maria Becker’s novel *Syrinx* (1914), who echoes Kinkel’s objections to “the brutality of our scales” (see Key 1–5, notes 249–50): “Do you know what we have done to the flying sea of sound? We have run it through a sieve and come up with these twelve drops, which give only a faint idea of the vastness of the primal sea.” Quoted and translated in Patteson, *Instruments for New Music*, 56–57.

253. Analogously, the digital game *Xenoblade Chronicles* (Monolith Soft, 2010–15) represents the determinism of Leibniz’s monadological philosophy (symbolized by the Monado, a mythical sword) under the aegis of a digital universe projected and materialized in line with his binary epistemology.

254. Callimachus, *Hymn 2 (to Apollo)*, line 106: “οὐκ ἄγαμαι τὸν ἀοιδὸν ὃς οὐδ’ ὄσα πόντος ἀείδει.” (“I do not admire the singer who sings less than the sea”; translation in Cheshire, “Kicking ΦΘΟΝΟΣ,” 354.)

255. *A Letter from Schoenberg* and *Deus Cantando* (2009) are part of Ablinger’s *Quadraturen III* series (1996–), but they also constitute the mechanical extrapolation of his *Voices and Piano* cycle (1998–) for human pianist: each “song” consists of the recreation of a vocal recording in scrupulously notated detail. Matthew Mendez provides an overview of Ablinger’s music that places the *Quadraturen III* and *Voices and Piano* projects in dialogue with Kittler and Lacan, analyzing their shifting configurations of automation, reproduction, and recreation by way of the various grids, filters, notes, and keys through which they are transmitted (Mendez, “It Is Always the OTHER That Creates Ourselves”).

256. G. Douglas Barrett places Ablinger's work in the context of automata as well as Michel Chion's notion of the *acousmètre* ("Between Noise and Language"). The technological means of digitizing speech via acoustic musical instruments was pioneered by Clarence Barlow (see Poller, "Clarence Barlow's Technique of 'Synthrummentation' and Its Use in *Im Januar am Nil*"). The original design of Ablinger's *Vorsetzer* was developed by Trimpin in collaboration with Conlon Nancarrow: such devices can be traced back via Debain's antiphonel (see Key 2–2, note 135) to the harpsichord illustrated in the frontispiece of Engramelle's *La tonotechnie* (1775). In parallel with the organological and historical relationship of "fortepiano" and "pianoforte," the term "piano player" distinguishes the *Vorsetzer* from the "player piano" that succeeded it while also signaling a subtle shift of agency: see Patteson, *Instruments for New Music*, 26.

257. Quoted in Barrett, "Between Noise and Language," 158.

258. Schoenberg, "VR48: Brief, Los Angeles, an Ross Russell, New York."

259. Schoenberg's wire recordings were typically transcribed by his amanuensis, Richard Hoffmann: see Ennulat, *Arnold Schoenberg Correspondence*, xi–xii.

260. In this regard, Väänänen's oscillographic and -scopic rendition of *Quake* (see Key 1–3, note 195) can be conceived as a counterpart to *A Letter from Schoenberg*: whereas the former analogizes digital data as quasi-sonic signals, the latter digitizes sonic signals via the discrete interface of the keyboard.

261. Throughout his career, Schoenberg was a fierce advocate for the intellectual property rights of composers, going so far as to defend Stravinsky's: see Szendy, *Listen*, 89–91.

262. At the time of writing, Arcangel's work could be viewed at coryarcangel.com/things-i-made/2009-003-dreiklavierstucke-op-11 As well as demonstrating play's extrahuman dimensions, Arcangel's feline "rendition" of Schoenberg's op. 11 evokes Montaigne's proto-Gadamerian thoughts on the cat-like nature of ludic reciprocity (see Prelude, note 6). It also reverses the sadistic dynamics of the apocryphal *Katzenklavier*, in which the keyboard "plays" a clowder of cats ordered according to the relative pitches of their yowls of protest: see Schott, *Magia universalis naturae et artis*, 2: plate following p. 372.

263. See Walden, "Schoenberg's Typewriter." Schoenberg was neither the first nor the last to undertake such an endeavor: comparable machines were devised by Xavier Progin (ca. 1833), Charles Spiro (1885), and Ludwig Massen (1910).

264. Unlike Arcangel's absurdist montage, Ablinger's work resonates with Schoenberg's own exploration of the piano's acoustic attributes via silently depressed notes in op. 11, no. 1, and elsewhere. As Joseph Auner observes, such techniques demonstrate how integral the resonance of individual sonic phenomena was to Schoenberg's expressionistic aesthetics ("Weighing, Measuring, Embalming Tonality," 33–36). On the broader history of the ways in which composers have taken advantage of the piano's oscillographic qualities, see Nonken, *The Spectral Piano*.

265. The impassioned, intoxicated Gambará plays his compositions on the Panharmonicon, a keyboard instrument modeled after Maelzel's famous orchestrion of the same name that was designed to simulate an entire orchestra—and even the human voice (Balzac, *Gambará*, 108 and 125; see also Dolan and Tresch, "A Sublime Invasion"; and Raz, "'The Expressive Organ within Us,'" 139–40). Thomas Mann described Leverkühn's abortive performance of *The Lamentation of Dr. Faustus* in analogous terms, Leverkühn's tears wetting the keys as he "attacked [them with] a strongly dissonant chord" before emitting a loud wail and falling unconscious (*Doctor Faustus*, 503).

266. See Key 1-2 and Mendez, "It Is Always the OTHER That Creates Ourselves."

267. It is significant that the drastic force of play has been a touchstone within performance studies writ large: see, for example, Schechner and Schuman, *Ritual, Play, and Performance*.

268. See Key 5-5, note 175.

KEY 3 THE EMERGENCE OF MUSICAL PLAY

1. Swift, *Travels into several Remote Nations of the World*, 2:73. Whether by accident or design, the impracticality of the professor's machine is illustrated by the fact that it is missing a crank, an oversight that was corrected in later editions. The episode expands on ideas and criticisms Swift had broached in "A Trritical Essay upon the Faculties of the Mind" (1707). Both despite and owing to Swift's satirical intent to represent the Literary Engine as unfeasible by design, Daniel Libeskind constructed a "writing machine" based on its blueprint that was exhibited at the Venice Biennale in 1985.

2. Swift, *Travels into several Remote Nations of the World*, 2:74. Jevons linked Swift's and Babbage's Engines when introducing his logical piano (Figure 19): see Jevons, "On the Mechanical Performance of Logical Inference," 498.

3. See Eco, *The Infinity of Lists*, 363-69.

4. On the informational ramifications of the combinatorial mechanisms skewered by the Literary Engine, see Kittler, *Discourse Networks, 1800/1900*, 45-53; Liu, *The Freudian Robot*, 39-97; and Nowvickie, "Ludic Algorithms."

5. See Eco, *The Infinity of Lists*, 366-69.

6. Hayes, *The Art of Composing Music*, 22. The requisite database would have been assembled from elemental "Notes and Passages" cut from existing scores and "pasted . . . on the little Pieces of Wood." *Ibid.*, 22.

7. *Ibid.*, 7-8 and 28. For context on Hayes's squib, see Deutsch, "Ink-Pot and Squirt-Gun"; Heighes, *The Lives and Works of William and Philip Hayes*, 28-32; and Richards, *The Free Fantasia and the Musical Picturesque*, 85-89.

8. Hayes, *The Art of Composing Music*, 22 and 21. Even though Gunn lived in Birmingham, "a Place famous for mechanic Operations" (*ibid.*, 22), Hayes had him ultimately reject this plan as unworkable.

9. Derrida, "Structure, Sign, and Play in the Discourse of the Human Sciences," 260: see Key 2-5, note 241.

10. Derrida, *Paper Machine*, 16.

11. *Ibid.*, 8 and 12.

12. *Ibid.*, 23. Writing under his own name, Hayes was overtly skeptical of the algorithmic and combinatorial logic exhibited by Geminiani's *Guida armonica*, discussed in Key 3-1: see Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 164-65.

13. Hans Pimmer provides a comprehensive catalog of *Würfelspiele* in *Würfelkomposition*: see also Ratner, "Ars Combinatoria"; Hauptenthal, "Geschichte der Würfelmusik in Beispielen"; Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 245-62; Zaslav, "Mozart's Modular Minuet Machine"; and Zbikowski, *Conceptualizing Music*, 137-54. While the generative mechanisms and musical idioms of *Würfelspiele* vary, their aleatoric and combinatorial principles remain broadly consistent.

14. On Krajewski's *Paper Machines*, see Key 1-2, notes 153-55; see also Campe, *The Game of Probability*.

15. See Key 5-5, note 176.

16. On van Swieten, see Krajewski, *Paper Machines*, 34-43; on Marpurg and his relationship with C.P.E. Bach, see Yearsley, "C.P.E. Bach and the Living Traditions of Learned Counterpoint."

17. Krajewski, *Paper Machines*, 33: the musical flashcards of Elisabetta de Gambarini (see note 12 above) presumably took advantage of the same properties.

18. See Zaslaw, "Mozart's Modular Minuet Machine," 221. The ludic method by which Prokofi v assembled the orchestral suite from *The Gambler* (see Key 1-1, note 95) might be understood to follow in this tradition.

19. See Caporaletti, "'Ghost Notes,'" 356-59; and Key 1-2.

20. See Edgar Landgraf's coupling of Derrida and von Foerster in *Improvisation as Art*, 4-5 and 33-41.

3-1 UNFOREHEARD CIRCUMSTANCES

21. Quoted and translated in Ernst, "From Media History to *Zeitkritik*," 139.

22. Caillois, *Les jeux et les hommes*, 43 (*Man, Play and Games*, 9): see also Costikyan, *Uncertainty in Games*.

23. See Key 1-1, notes 88-93.

24. Since the eighteenth century, these ludic properties have often been harnessed for didactic purposes, whereby games teach utilitarian, ethical, or theological lessons about personal conduct: see Goodfellow, "The Development of the English Board Game, 1770-1850"; and Jackson, "A Game Theory of Evangelical Fiction."

25. On recent configurations of "emergence" in the context of second-order cybernetics and systems theory, see Clarke and Hansen, *Emergence and Embodiment*; on the application of the concept to contemporary forms of musical improvisation, see Borgo, *Sync or Swarm*.

26. Gerhard Nierhaus traces the ramifications of cellular automata for the generation of music in *Algorithmic Composition*, 187-204. Maxis's "life simulation" digital game *Spore* (2008), which features a generative soundtrack produced by Brian Eno, provides a ludomusical illustration of these principles in action.

27. Ratner, *Classic Music*, 436.

28. Ratner, "Ars Combinatoria"; Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 71 and 99-121; and Nierhaus, *Algorithmic Composition*, 17-39: see also Key 1-2, note 165; and Key 2-1, note 38. Mizler's "thoroughbass machine" was modeled after the calculating machine devised and built by Leibniz, but was met with disdain by the merciless Johann Adolph Scheibe: see Yearsley, *Bach and the Meanings of Counterpoint*, 181-8; and Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 131-44.

29. On Kircher's *arca musarithmica* in musical, theological, mathematical, and media-archaeological contexts, see Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 15-48; and Zielinski, *Deep Time of the Media*, 141-57. In England, the principles of the *arca musarithmica* were independently put to comparable musical ends by Thomas Campion in his *A New Way of Making Fowre Parts in Counterpoint* (1615) and John Birchenha's algorithmic *Rules of Composition* (ca. 1660): Birchenha's pupil Samuel Pepys later acquired his own *arca musarithmica* (see Field and Wardhaugh, *John Birchenha*, 43).

30. See Guido and Schubert, “Unpacking the Box in Frescobaldi’s *Ricercari* of 1615,” which reverse-engineers a tradition to which the contrapuntal tour de force with which Mozart crowned the finale of his “Jupiter” Symphony, K. 551 (1788) might be deemed to belong: see Ratner, *Classic Music*, 98–102.

31. *Haec atque talia ex hominum genere ludibria sibi, nobis miracula, ingeniose fecit natura*. Pliny the Elder, *Natural History* 7.32, translated in Findlen, “Jokes of Nature and Jokes of Knowledge,” 296.

32. *Ibid.*, 300. Kircher nonetheless retained a belief in the playful nature of nature, as a letter to Francesco Carli concerning “fl wvers” that spontaneously emerged from a residue of talcum makes clear (quoted and translated in Findlen, “Jokes of Nature and Jokes of Knowledge,” 316).

33. Quoted and translated in *ibid.*, 298.

34. Quoted and translated in *ibid.*, 319.

35. See Figure 13.

36. “Je souhaiterais qu’un habile mathématicien voulût faire un ample ouvrage bien circonstancié et bien raisonné sur toute sorte de jeux, ce qui serait de grand usage pour perfectionner l’art d’inventer, l’esprit humain paraissant mieux dans les jeux que dans les matières les plus sérieuses.” Leibniz, *Nouveaux essais sur l’entendement humain*, 415. Leibniz could be said to have been calling for the formal game theory of von Neumann and Morgenstern, discussed in Key 1-1 and Key 2-0.

37. Niedt, *Handleitung zur Variation* (1706); Riepel, *Grundregeln zur Tonordnung* (1755), issued as the second volume of his *Anfangsgründe zur musicalischen Setzkunst*; Koch, *Versuch einer Anleitung zur Composition* (1782–93); Geminiani, *Guida armonica* (1756); and Galeazzi, *Elementi teorico-pratici di musica* (1791–96). Long after publishing his dice game (*Der allezeit fertige Polonoisen- und Menuettencomponist*, 1757), Kirnberger published a pamphlet containing a method for splicing together preexistent materials to create a “new” piece (*Methode Sonaten aus’m Ermel zu schüddeln*, 1783) in a manner that recalls the ancient paradox of the Ship of Theseus while anticipating the modern codification of genetic algorithms, on which see Nierhaus, *Algorithmic Composition*, 157–86.

38. Zaslav, “Mozart’s Modular Minuet Machine,” 225.

39. See Helm, “Six Random Measures of C.P.E. Bach,” 145; Hedges, “Dice Music in the Eighteenth Century,” 182; Hauptenthal, “Geschichte der Würfelmusik in Beispielen,” 122–3; Ratner, “*Ars Combinatoria*,” 357–58; and Yearsley, *Bach and the Meanings of Counterpoint*, 184.

40. As Peter Schubert observes (and C.P.E. Bach’s *Einfall* demonstrates), the feat of spontaneously generating invertible counterpoint was less rarefied than it might have appeared to the uninitiated (“From Improvisation to Composition,” 129). Marpurg’s analysis of Bach’s *Einfall* (*Historisch-kritische Beiträge zur Aufnahme der Musik*, vol. 3, bk. 2, 170–74) was directly informed by the combinatorial mathematics of Kirnberger’s *Der allezeit fertige Polonoisen- und Menuettencomponist*, which Marpurg also investigated (*ibid.*, 135–54). It was in light of such calculations that Burney criticized Kirnberger as “more ambitious of the character of an algebraist, than a musician of genius.” Burney, *The Present State of Music in Germany, the Netherlands, and the United Provinces*, 213.

41. As Johann Friedrich Reichardt observed in 1774, “in neuern Zeiten ist zu dem Anhören und Ausüben noch das Selbstschreiben hinzu gekommen.” Reichardt, *Über die deutsche*

comische Oper, 20–21. For an overview of eighteenth- and early-nineteenth-century pedagogical treatises that provided instruction on improvisatory techniques, see Berkowitz, *The Improvising Mind*, 15–38.

42. On operational closure, see Key 1–3, note 185.

43. Descartes, “Rules for the Direction of the Mind,” 1; Hacking, *Historical Ontology*, 84. On the early modern development of rule-based technical literature, see Luhmann, *Art as a Social System*, 198–99.

44. See Wegman, “What Is Counterpoint?” 18–33; Schubert, “Counterpoint Pedagogy in the Renaissance”; and Guido, “Counterpoint in the Fingers.”

45. Wegman, “What Is Counterpoint?” 33–47; Schubert, “From Improvisation to Composition.”

46. Guido notes that Diruta distinguished between *contrappunto osservato*, which obeyed the laws to the letter, and *contrappunto commune*, “a kind of simplified, less accurate and less refined but practical way of creating music.” Guido, “Counterpoint in the Fingers,” 66.

47. Throughout the seventeenth and eighteenth centuries, the taxonomical imperative also informed the broad division of music into styles and genres along lines that can be traced back to Johannes de Garlandia. Danuta Mirka provides an overview of these developments in *The Oxford Handbook of Topic Theory*, 3–9.

48. From Johann David Heinichen (1711) to Michaelis (1806), German writers seemed to have Kircher’s *arca musarithmica* in mind when stressing the inadequacy of merely shuffling the order of “wooden notes” via a “mechanical compositional process” that lacked “tenderness or soul,” on the one hand, and the “organization” produced by “mutually functional relations,” on the other (Heinichen, *Neu erfundene und gründliche Anweisung zu vollkommener Erlernung des General-Basses*, 12–B; Michaelis, “Ein Versuch, das Wesen der Tonkunst zu entwickeln,” 683). I am grateful to Holly Watkins for bringing Michaelis’s article to my attention. In the twentieth century, these types of distinctions were formalized under the rubric of Chomsky’s generative grammar, the musical implications of which Nierhaus summarizes from the reciprocal perspectives of composition and analysis (*Algorithmic Composition*, 83–120).

49. On the genealogy of tables and their functions as literary devices, see Campe, *The Game of Probability*, 197–247. In musical terms, the twofold functions of tabular mapping are evident (if not always explicitly presented as such) in the *tabula naturalis* and the *fundamenta* exercises by which German organists were trained to improvise and compose from the fifteenth through the seventeenth centuries: see Dahlhaus, *Studies on the Origin of Harmonic Tonality*, 118–9; and Christensen, “*Fundamenta Partiturae*,” esp. 17–22.

50. Czerny, *Letters to a Young Lady, on the Art of Playing the Pianoforte*, 80.

51. *Ibid.*, iv; Czerny, *A Systematic Guide to Improvisation on the Pianoforte*. On the gendered assumptions and implications of Czerny’s *Letters*, see Davis, “The Veil of Fiction.”

52. Niedt, *The Musical Guide*, 86 and 88; see also Christensen, “*Fundamenta Partiturae*,” 31–3. The *Handleitung zur Variation* was revised and published as the second volume of Niedt’s *Die musicalische Handleitung* in 1721. Niedt’s method drew on combinatorial principles by which intervallic *movimenti* could be derived that had been outlined by Francesco Bianciardi (1607) as well as Diruta (1609) and were further enumerated by Johann Nennig, known as Spiridionis, in the 1670s: see Menke, “*Ex Centro* Improvisation,” 77–82; and Guido, “Counterpoint in the Fingers.” On the *monte romanesca*, see Gjerdingen, *Music in the Galant Style*, 98–106.

53. Niedt, *The Musical Guide*, 88–109.
54. I am grateful to Jonathan Schakel for sharing this observation: see also Key 2–3, note 172.
55. I refer here to Suits’s definition of gameplay: see Key 1–4, note 244.
56. Geminiani, preface to the *Guida armonica*.
57. Burney, *A General History of Music*, 4:642; see also Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 164–66.
58. Niedt, *The Musical Guide*, 28.
59. On Riepel’s deployment of principles associated with the *ars combinatoria*, see Eckert, “Ars Combinatoria, Dialogue Structure, and Musical Practice in Joseph Riepel’s *Anfangsgründe zur musicalischen Setzkunst*”; and Klotz, *Kombinatorik und die Verbindungskünste der Zeichen in der Musik*, 223–44.
60. Geminiani, preface to the *Guida armonica*.
61. Plato, *Phaedrus* 275d.
62. The flexibility of Niedt’s method formed a conspicuous contrast to the stiffness of traditional instruction in keyboard *Tablatur*, which produced only “paper organists” (Niedt, *The Musical Guide*, 23; see also Christensen, “*Fundamenta Partiturae*,” 32–42).
63. Krämer and Bredekamp, “Culture, Technology, Cultural Techniques,” 23. In musical terms, Krämer and Bredekamp’s observations chime with Caporaletti’s notion of “audiotactility” as invoked in “Ghost Notes,” 348–55, as well as with Guido’s approach in “Counterpoint in the Fingers.”
64. See Key 1–0, notes 20–25.
65. On such relationships, see Key 1–4, note 217; and Key 2–1, note 69.
66. Czerny, *Letters to a Young Lady, on the Art of Playing the Pianoforte*, 79. For Diderot and/or Bemetzrieder, too, the “labyrinth of the twenty-four keys” was best explored “by chance and without design,” since one could thereby stumble on “very successful tonal combinations” (quoted and translated in Jerold, “Diderot [Part I],” 49; see also Key 2–4, note 218).
67. See Key 2–3, note 159.
68. See Key 5–5, note 177.
69. Czerny, *Letters to a Young Lady, on the Art of Playing the Pianoforte*, 79.

3-2 PANTOMIMES AND PARTIMENTI

70. See Key 5–5, note 178.
71. See Bauer, *Mozart*; and Bauer, “Mozart, Kavalier und Spieler.” On various aspects of Mozart’s playfulness, see also Winternitz, “Gnagfl w Trazom”; Pesic, “The Child and the Daemon”; Chua, “Myth”; Schmidt, “Komponieren als intellektuelles Spiel”; Strouhal, “Versuch über die Schaukel”; Byros, “Trazom’s Wit”; and Berger, *Bach’s Cycle, Mozart’s Arrow*, 179–98.
72. On the ludic culture of Mozart’s Vienna, see Pezzl, *Skizze von Wien*, 5:917–18. As Winternitz observed, skittles, billiards, shooting, and dancing all rely on “accurate control of body movement and a special and subtle command of space,” as do the writing and playing of music (“Gnagfl w Trazom,” 207). On Mozart’s predilection for these pastimes and the compositional activities related to them, see Bauer, *Mozart*, esp. 169–222; Weingartner, “Billard”; Witzmann, “Sposi, amici, al ballo, al gioco . . .”; Leopold, “Wenn diener Menuette tanzen”; and McKee, “Ballroom Dances of the Late Eighteenth Century.”

73. See Bauer, *Mozart*, 17–68; and Zaslav, “Mozart’s Modular Minuet Machine,” 227–33.
74. Quoted and translated in Bauer, *Mozart*, 200.
75. See in particular Marivaux’s *Le jeu de l’amour et du hazard* (1730) and *La double inconstance* (1723); on Fragonard’s erotic and whimsical representations of games and play, see Milam, *Fragonard’s Playful Paintings*. Act 2, scene 8, of *Così fan tutte* opens with Fernando’s confident declaration to Guglielmo that their selection of lovers has been as rare and felicitous as a lottery jackpot.
76. See Richards, “The *Commedia dell’Arte* Acting Companies.”
77. Gjerdingen, *Music in the Galant Style*, 8–10; Gjerdingen, “*Partimento, que me veux-tu?*” 91; Sanguinetti, *The Art of Partimento*, 167–68; Knepler, *Wolfgang Amadé Mozart*, 104; and Keener, “Calmo’s Counterpoint.” For accounts of dialogical instrumental improvisation involving Giovanni Paisiello and Karl Ditters von Dittersdorf, see Rice, “Improvising Face to Face”; and Key 4–2, note 69.
78. Gjerdingen foregrounds the ludic aspect of extemporaneous *partimento* realization by describing the player’s shifting “from defending to attacking” with the goal of “[scoring] artistic points” (*Music in the Galant Style*, 474).
79. See Müller-Kampel, *Hanswurst, Bernadon, Kasperl*. On Haydn’s involvement with Bernadon, see Van Horn Melton, “School, Stage, Salon,” 95–102; Beghin, *The Virtual Haydn*, 77–125; and note 111 below.
80. See Landgraf, *Improvisation as Art*, 42–47; and Sisman, “Haydn, Shakespeare, and the Rules of Originality,” 22–23.
81. See Görner, *Der Hans Wurst-streit in Wien und Joseph von Sonnenfels*; and Abert, *W.A. Mozart*, 616–18. These events reprised the seventeenth-century institutional tensions in France delineated by Georgia Cowart (“Carnival in Venice or Protest in Paris?”).
82. On the literary transmutation of the *commedia dell’arte* at the hands of Goethe, Karl Philipp Moritz, Hoffmann, and others, see Landgraf, *Improvisation as Art*, 47–108; and Esterhammer, *Romanticism and Improvisation*, 129–46.
83. See Mozart to Maria Anna Mozart, February 10, 1770, in *Briefe*, 1:34. In or around 1787, Mozart sketched the opening of a comic farce called *Der salzburger Lump in Wien* (“The rogue from Salzburg in Vienna”) and another, *Die Liebesprobe*, that featured a servant named Wurstl: see Scheit, “Mozart und Hans Wurst,” 69–70; and Borchmeyer, “Mozarts Hanswurstiaden,” 505–6. David P. Schroeder has pointed out resemblances between Hanswurst and characters from Mozart’s operas, most notably Papageno from *Die Zauberflöte* and Pedrillo from *Die Entführung aus dem Serail* (*Mozart in Revolt*, 35–36). Mozart’s interest in the *commedia dell’arte* can perhaps be traced back to his memorable experience of the Venetian carnival as a teenager: on his enthusiastic participation in all manner of festivities, balls, and masquerades, see Bauer, *Mozart*, 273–346.
84. “You know, of course, that we are in the middle of the carnival season and that there’s a lot of dancing here just as there is in Salzburg and Munich.—and I would like to go dressed up, but please don’t say a word to anyone, as a Harlequin—because around here there are so many—indeed nothing but—asses at the Redoute;—therefore, I would like to ask you to send me your Harlequin costume—but it would have to be very soon—we are not going to the ball until we have the masks, although everything is already in full swing.” Mozart to Leopold Mozart, January 22, 1783, in *Briefe*, 3:251–2; translation in Spaethling, *Mozart’s Letters*, 339–40.

85. Mozart to Leopold Mozart, February 15, 1783, in *Briefe*, 3:257; translation in Spaethling, *Mozart's Letters*, 343. For more detail on the circumstances surrounding the pantomime, see Schroeder, *Mozart in Revolt*, 173–94; and Witzmann, “Will der Herr Graf den Tanz mit mir wagen . . .,” 436–38.

86. Mozart to Leopold Mozart, March 12, 1783, in *Briefe*, 3:259; translation in Spaethling, *Mozart's Letters*, 345.

87. The remnants of the pantomime are published as “Musik zu einer Fasnachtspantomime, K. 446/416d” *Neue Mozart Ausgabe* II/6/2, 120–27. In light of his role as pantomimic versifier, there is a degree of irony in Müller’s function as the spearhead of Joseph II’s ultimately fruitless efforts to undermine the Viennese institutionalization of Italian opera—and thereby to eliminate the invidious influence of the *commedia dell’arte*—by founding a national *Singspiel* (see Abert, *W.A. Mozart*, 617–19). In this particular case, Mozart was unimpressed by the quality of Müller’s written output (see Mozart to Leopold Mozart, March 12, 1783, in *Briefe*, 3:259; translation in Spaethling, *Mozart's Letters*, 345). Nonetheless, the verses presumably served to circumvent the ban on improvised theater, should that have remained a concern in light of the pantomime’s extratheatrical location and *intermezzo*-like function.

88. Independent of Müller’s verses, this *canovaccio* was presumably of Mozart’s own devising.

89. In this regard, I am grateful to Robert Levin for introducing me to Alfred Schnittke’s (post)modern work *Moz-Art à la Haydn*, issued in various formats between 1974 and 1990, in which the pantomime’s materials are stitched together and strikingly juxtaposed. Schnittke measures the historical distance between the eighteenth and twentieth centuries by taking Mozart’s fragmentary text almost absurdly literally: veering from the cacophonous to the witty, the results are perhaps closer to the spirit of the *commedia dell’arte* than they might initially seem.

90. Le Guin, *Boccherini’s Body*; Beghin, *The Virtual Haydn*. See also Cook, *Beyond the Score*, 311–4.

91. Berliner, *Thinking in Jazz*; Monson, *Saying Something*, 73.

92. See Iyer, “Exploding the Narrative in Jazz Improvisation.”

93. With regard to extemporization in eighteenth- and nineteenth-century European idioms, Caporaletti warns against the wholesale importation of improvisatory paradigms from jazz studies (“‘Ghost Notes,’” 345–46). While the specific differences between idioms must be navigated with care, parallels may nonetheless be productively—if cautiously and provisionally—drawn.

94. Gjerdingen, *Music in the Galant Style*, 465–80; Gjerdingen, “*Partimento, que me veux-tu?*”; Gjerdingen, “A Source of Pasquini Partimenti in Naples”; and Sanguinetti, *The Art of Partimento*.

95. On the chaotic acoustic environments of Neapolitan *conservatori*, which left Burney at a loss to explain how they could produce such renowned composers and performers, see Gjerdingen, “Editorial”; and Sanguinetti, *The Art of Partimento*, 29–46.

96. On *partimenti*, see Key 2–3.

97. See Figure 42; Key 3–1, note 56; and Key 2–3, notes 154–58.

98. Gjerdingen, “*Partimento, que me veux-tu?*,” 91; Gjerdingen, *Music in the Galant Style*, 8; and Sanguinetti, *The Art of Partimento*, 54. Tellingly, the largest surviving corpus of *canovacci* is Neapolitan: see Cotticelli, Heck, and Heck, *The Commedia dell’Arte in Naples*.

99. On improvisation within the *commedia dell'arte* tradition, see Henke, *Performance and Literature in the Commedia dell'Arte*, 12–30; Henke, “Form and Freedom”; Spencer Kennard, *Masks and Marionettes*, 45–65; and Richards and Richards, *The Commedia dell'Arte*, 185–209.

100. *Ibid.*, 186.

101. “[Les] pièces italiennes ne sauraient s'imprimer. La raison est que les comédiens italiens n'apprennent rien par coeur et qu'il leur suffit, pour jouer une comédie, d'en avoir vu le sujet un moment avant que d'entrer sur le théâtre. . . . Qui dit *bon comédien italien* dit un homme qui a du fonds, qui joue plus d'imagination que de mémoire; qui compose, en jouant, tout ce qu'il dit. . . . [Il] marie si bien ses paroles et ses actions avec celles de son camarade qu'il entre sur le champ dans tout le jeu et dans tous les mouvements que l'autre lui demande, d'une manière à faire croire à tout le monde qu'ils étaient déjà concertés.” Gherardi, *Le théâtre italien*, 1:61–62.

102. On the competitive and cooperative aspects of such dialogical exchange, through which “the life-blood of *arte* improvisation” flowed, see Henke, *Performance and Literature in the Commedia dell'Arte*, 24–30.

103. Esterhammer, *Romanticism and Improvisation*, 130.

104. Some of Pasquini's *partimenti* were devised to be performed by two players, often cast in the roles of leader and follower: see Gjerdingen, “*Partimento, que me veux-tu?*” 102; and Sanguinetti, *The Art of Partimento*, 278–82. This tradition was documented, domesticated, didacticized, and ironized by Haydn's *Il maestro e lo scolare*, Hob. XVIIa:1 (1778), on which see Beghin, *The Virtual Haydn*, 121–24.

105. See Key 3–1, note 58.

106. On the intricate triangulation of Italian, German, and French musical theory and praxis as mediated at the keyboard, see Buelow, “The Italian Influence in Heinichen's *Der General-Bass in der Composition*”; Gingras, “Partimento Fugue in Eighteenth-Century Germany”; Renwick, *The Langloz Manuscript*; Kirshoff, *LA.B.C. Musical*; Christensen, “Thoroughbass as Music Theory”; Christensen, “*Fundamenta Partiturae*”; Diergarten, “Beyond ‘Harmony’”; and Caffeo, “The Early Reception of Neapolitan Partimento Theory in France.”

107. Niedt, *The Musical Guide*, 24. On improvisation in Goethe's *Wilhelm Meisters Lehrjahre*, see Esterhammer, *Romanticism and Improvisation*, 136–39; and Landgraf, *Improvisation as Art*, 47–53.

108. See Caffeo, “The Early Reception of Neapolitan Partimento Theory in France,” 152–53.

109. On relationships between the *partitura* and *partimento* traditions and Eberlin's pedagogical materials, see Diergarten, “Beyond ‘Harmony,’” esp. 63–64.

110. On Mozart's unforeseen encounter with a short-octave pedalboard in Augsburg, see Beghin, *The Virtual Haydn*, 83–84. On his impromptu keyboard contest with Johann Wilhelm Hässler, which took place in an organ loft as well as at the residence of the Russian ambassador in Dresden, see Mozart to Constanze Mozart, April 16, 1789, in *Briefe*, 4:82–84; translation in Spaethling, *Mozart's Letters*, 407–8. The following precedes Mozart's request for the Harlequin costume: “I will soon send the cadenzas and *Eingänge* [for the keyboard concertos K. 175 and K. 271] to my dear sister. I haven't yet changed the *Eingänge* in the Rondo [K. 382], because when I perform the concerto I always play what occurs to me at the moment.” Mozart to Leopold Mozart, January 22, 1783, in *Briefe*, 3:251; translation in Spaethling, *Mozart's Letters*, 339.

111. Beghin, *The Virtual Haydn*, 104–120: see also Wheelock, “Mozart’s Fantasy, Haydn’s Caprice,” 331–4. On Haydn’s “audition” for Kurz-Bernardon, at which he was called upon to improvise suitable music to accompany the actor’s ludicrous pantomime by any means necessary, see Van Horn Melton, “School, Stage, Salon,” 93–94; and Beghin, *The Virtual Haydn*, 103–4.

112. On a recent attempt to realize Mozart’s pantomime via collective instrumental extemporization, see Moseley, “Mozart’s Harlequinade.” The treatment of Mozart’s first-violin part as a “fundamental soprano,” or *chant donnée*, in Sanguinetti’s terms (*The Art of Partimento*, 63), might be imagined to perform a Tartinian inversion of the prevailing theoretical models that privileged the bass as the source of harmony and melody. On the origins and implications of this approach, see Polzonetti, “Tartini and the Tongue of Saint Anthony,” esp. 441.

113. Henke, *Performance and Literature in the Commedia dell’Arte*, 189: see also Crohn Schmitt, “*Commedia dell’Arte*.”

114. Rumph, *Mozart and Enlightenment Semiotics*, 37 and 36. On the disjunction between Koch’s rhetoric and Viennese compositional practice, see also Diergarten, “At Times Even Homer Nods Off;” [16].

115. Zbikowski, “Dance Topoi, Sonic Analogues, and Musical Grammar,” 290. Kirnberger himself stressed the importance of “determining the true character of the various commonly accepted dance melodies.” Kirnberger, *The Art of Strict Musical Composition*, 279.

116. See Pimmer, *Würfelkomposition*, 50–53.

117. See Key 1–5, note 267. As Wye Jamison Allanbrook notes, the correlation of tempo and pitch with character can be traced back to Aristotle’s *Nicomachean Ethics*, in which “slow movement . . . and a deep voice” is said to characterize “the great-souled man” (quoted and translated in *The Secular Commedia*, 59).

118. Allanbrook, *The Secular Commedia*, 60: see also McKee, “Ballroom Dances of the Late Eighteenth Century,” 174–77.

119. Allanbrook, *The Secular Commedia*, 60.

120. *Ibid.*, 57–58 and 73.

121. Ratner, *Classic Music*; Allanbrook, *Rhythmic Gesture in Mozart*, 1–70; Allanbrook, *The Secular Commedia*, 109–11; and Agawu, *Playing with Signs*, 30.

122. See Allanbrook, *The Secular Commedia*, 8–22, 33–36, 61–70, and 90–127.

123. See *ibid.*, 56–57: on the masked and otherwise veiled jibes aimed at Louis XIV in the wake of his banishment of the *Comédie-Italienne*, see Cowart, “Carnival in Venice or Protest in Paris?”

124. Diderot, *Le neuveu de Rameau*, 188–97: see Allanbrook, *The Secular Commedia*, 23 and 174–76. On pantomimesis, see Gregg Daniel Miller, *Mimesis and Reason*, 63–65. As noted in Key 1–1, the etymological roots of both mimesis and *mimicry* converge on μῖμος (*mimos*), which itself gave rise to παντόμιμος (*pantomimos*), referring to actors or dancers who played a series of different characters, regardless of sex or class.

125. Gumbrecht, *Atmosphere, Mood, Stimmung*, 59.

126. See Allanbrook, *The Secular Commedia*, 33–40.

127. Müller, *Kritische, ästhetische und philosophische Schriften*, 1:310; translation slightly adapted from Landgraf’s in *Improvisation as Art*, 104–5.

128. In the preface to his play *Harlequin's Invasion*, written for its revival in 1762, David Garrick praised the mimetic virtuosity of John Rich, a renowned Harlequin who performed under the stage name Lun: "When Lun appear'd, with matchless art and whim / He gave the pow'r of speech to every limb; / Tho' mask'd and mute, conveyed his quick intent, / And told in frolic gestures all he meant." Knepler interpreted Mozart's performance as Harlequin in a similar light: "Like improvised music-making, improvisation on stage derives from the earliest forms of mimetic communication, nourished on sources which sustained man's artistic behaviour before it was codified in rules, instructions and traditions." Knepler, *Wolfgang Amadé Mozart*, 104.

129. Such figures occasionally appeared on stage as well as on the mantelpiece: *Ballet royal de la nuit* (1653), a *ballet de cour* commissioned by the young Louis XIV, features "Jeux," an allegorical character whose costume features cards strung around his waist, a chessboard draped over his shoulders, and buttons that double as dice (illustrated in Chilton, *Harlequin Unmasked*, 41). "Jeux" at once represents and observes the delights of nocturnal entertainment, which include a *commedia dell'arte* pantomime. I am grateful to Erica Levenson for bringing this ludic figure to my attention.

130. The melodic, harmonic, and affective framework here is ironically akin to the climactic moment when the statue of the Commendatore arrives for dinner in *Don Giovanni* ("Don Giovanni, a cenar teco!," act 2, no. 19).

131. The music at mm. 13-15 is gesturally redolent of Pamina's aria "Ach, ich fühl's" (*Die Zauberflöte*, act 2, no. 17). On the gendered implications of the keys in which Mozart chose to represent his female characters (among which G minor is particularly prominent), see Wheelock, "Schwarze Gredel and the Engendered Minor Mode in Mozart's Operas."

132. On the genealogy and implications of representations of Turkishness and their intersection with the performance of status and gender within the *commedia dell'arte* tradition, see Wilbourne, "Lo Schiavetto (1612)," 21-24; and Esterhammer, *Romanticism and Improvisation*, 147-51.

133. Callow, foreword to Antonio Fava, *The Comic Mask in the Commedia dell'Arte*, vii. Esterhammer reads Hoffmann's *Prinzessin Brambilla* (1820) in similar terms (*Romanticism and Improvisation*, 140-46).

134. Schroeder, *Mozart in Revolt*, 175-80; see also Burnham, *Mozart's Grace*, 158. Schroeder reads Mozart's identification with Harlequin as symptomatic of his chameleon-like ability and tendency to act, react, dissemble, and deceive, particularly in relation to his father, a line that Maynard Solomon also pursues throughout his psychobiography (*Mozart*).

135. On the application of Bourdieu's "theory of practice" to the *commedia dell'arte*, see Esterhammer, *Romanticism and Improvisation*, 135-37.

136. See Crohn Schmitt, "Commedia dell'Arte," 61-63; and Landgraf, *Improvisation as Art*, 1-3.

137. On the complex and controversial roles played by Goldoni in this regard, see Spezzani, *Dalla commedia dell'arte a Goldoni*; Pietropaolo, "The Theatre," 20-29; and Griffin "Goldoni and Gozzi."

138. See Henke, *Performance and Literature in the Commedia dell'Arte*, 31-9.

139. In 1769, the playwright and librettist Desboulmiers provided evidence of such practices, which can be read opposite Gherardi's in note 101 above: "When the same piece is being played, the comedians take great care to remember those passages which were effective

on the fi st night, and do not hesitate to make use of them. . . . [Thus] the improvisation becomes basically an aff ir of memory, whereby the actor only provides the links between part and part, together with a well-arranged dialogue.” Desboulmiers, *Histoire du théâtre de l’Opéra comique*, 1:34–35; translation in Nicoll, *The World of Harlequin*, 38.

140. “I’m going to write a German opera just for *myself*;—I have chosen a comedy by Goldoni—“Il servitore di Due Padroni”—and the fi st Act is already translated—Baron Binder is the translator.” Mozart to Leopold Mozart, February 5, 1783, in *Briefe*, 3:255; translation in Spaethling, *Mozart’s Letters*, 342. Despite its alignment with Josephinian reforms, Mozart had no realistic prospects of staging the opera, and the plan quickly evaporated: Daniel Heartz’s “Goldoni, *Opera Buffa* and Mozart’s Advent in Vienna” provides contextual information on the abortive project.

141. To make the most obvious connections, Susanna and Despina are more or less sophisticated iterations of Colombine and Cherubino maps neatly onto Pierrot, while both Figaro and Leporello display Harlequinesque attributes.

142. Quoted and translated in Heartz, *Mozart’s Operas*, 172. Rather than violating the textual integrity of *Don Giovanni*, the approach recalled by Bassi is consistent with its complex philological status, itself a result of Mozart’s willingness to tailor the score to the requirements of different performers, audiences, and venues: see Woodfi ld, *The Vienna “Don Giovanni,”* 142–50.

143. Landgraf, *Improvisation as Art*, 8. In a similar vein, Berger echoes Karl Barth in discerning “the closeness of composition and improvisation in Mozart’s creative thinking, and the essential rule-governed freedom of both.” Berger, *Bach’s Cycle, Mozart’s Arrow*, 191: see also Key 4–3, notes 141–43.

144. “When Papageno’s aria with the Glockenspiel came on, at that moment I went backstage because today I had a kind of urge to play the Glockenspiel myself.—So I played this joke: just when Schikaneder came to a pause, I played an arpeggio—he was startled—looked into the scenery and saw me—the 2nd time he came to that spot, I didn’t play—and this time he stopped as well and did not go on singing—I guessed what he was thinking and played another chord—at that he gave his Glockenspiel a slap and shouted “*shut up!*”—everybody laughed.—I think through this joke many in the audience became aware for the fi st time that Papageno doesn’t play the Glockenspiel himself.” Mozart to Constanze Mozart, October 8–9, 1791, in *Briefe*, 4:159–61; translation in Spaethling, *Mozart’s Letters*, 441. Knepler (*Wolfgang Amadé Mozart*, 104) and Pesic (“The Child and the Daemon,” 99–100) offer ludic readings of the episode.

3-3 FROM BLACK BOX TO GLASSY SHELL

145. On the improvisatory concepts of “platform” and “tilt,” see Johnstone, *Impro for Storytellers*, 89–100.

146. Allanbrook, *The Secular Commedia*, 31–33.

147. On the playfully popular character of the rondo and its checkered critical reception, see Richards, *The Free Fantasia and the Musical Picturesque*, 133.

148. For an eloquent invocation of this theatrical ambiguity with regard to the “open closure” of Mozart’s music, see Burnham, *Mozart’s Grace*, 164.

149. Frye, *Anatomy of Criticism*, 212.

150. “Wenn große Künstler ein Werk vollenden, so kann man sagen: so muß es seyn.” Hegel, *Grundlinien der Philosophie des Rechts*, 52.

151. As John Durham Peters observes, play is an “age-old [form] of reversibility” that “fends off death” (*The Marvelous Clouds*, 310): see also Key 1-1, note 124. On the centrality of coincidence and accident to the *commedia dell'arte*, see Crohn Schmitt, “*Commedia dell'Arte*,” 58; on comedic blocking in *La serva padrona*, see Allanbrook, *The Secular Commedia*, 35-36; and on Müller, see note 127 above.

152. As Kramer puts it, channeling Benjamin, “the fidelity of text smothers the enlivening process through which the work is conceived.” Kramer, *Unfinished Music*, 207.

153. Lamenting Ananke’s triumph over Tyche, Allanbrook sought to restore a sense of vitality and contingency to music at risk of sounding all too familiar by resisting the Romantic forces that had reified Mozart’s scores as exemplars of “classical” virtues: see *The Secular Commedia*, 26-31, 42-44, and 172-74.

154. Quoted and translated in Solomon, *Mozart*, 357.

155. Pietropaolo, “Improvisation as a Stochastic Composition Process,” 168. On Derrida’s construal of the paradoxical relation between improvisation, originality, repetition, and reiteration, see Landgraf, *Improvisation as Art*, 4-5.

156. See Müller-Kampel, *Hanswurst, Bernadon, Kasperl*, 177.

157. Pietropaolo, “Improvisation as a Stochastic Composition Process,” 172-74.

158. Luhmann, *Art as a Social System*, 260. On this point, Luhmann cites Matteo Pellegrini: “Ogni concerto e sempre necessariamente somministrato dall’occorso di qualqu’altro concerto.” Quoted in *ibid.*, 260.

159. See Key 1-0, notes 30-32; and Key 5-5, note 180.

160. Allanbrook, *The Secular Commedia*, 17-18; see also Sutcliffe, “The Shapes of Sociability in the Instrumental Music of the Later Eighteenth Century,” 6-8; and Rumph, *Mozart and Enlightenment Semiotics*, 24. Acknowledging the same phenomenon, Kofi Agawu noted that “the identity of a topic is least dependent on the name of that topic. What matters, following the structuralist idea of relationality, is the difference between various topics.” Agawu, *Playing with Signs*, 49.

161. “The composer can most clearly differentiate for the hearts of his listeners . . . the sublime [*Erhabne*] from the playful [*Scherzenden*]” (Koch, *Versuch einer Anleitung zur Composition*, 2:34; translation in Baker and Christensen, *Aesthetics and the Art of Musical Composition in the German Enlightenment*, 152); Koch, *Musikalisches Lexikon*, s.v. “Styl, Schreibart;” translation in Allanbrook, *The Secular Commedia*, 125.

162. Quoted in Sutcliffe, “The Shapes of Sociability in the Instrumental Music of the Later Eighteenth Century,” 3; Hosler, *Changing Aesthetic Views of Instrumental Music in 18th-Century Germany*, 1.

163. Ratner, “Topical Content in Mozart’s Keyboard Sonatas,” 616; Allanbrook, *The Secular Commedia*, 120. See also Rumph, “Topical Figurae,” 498; and Guymier, “Eloquent Performance,” 594-95. The point is especially applicable to instruments possessed of a *Stossmechanik* (pushing action), which produced “crisp and harpsichordlike or disarmingly warm and tender [tones], with surprisingly little in between,” as Beghin puts it (*The Virtual Haydn*, 37-38). The more even gradation of the dynamic and registral continua produced by the later *Prellmechanik* gave rise to the neutrality observed by Hoffmann: see Key 2-2, note 10.

164. Allanbrook, *The Secular Commedia*, 17 and 111.

165. On operational closure, see Key 1-3, note 185. The digital game *Commedia dell'Arte: Masks, Masters and Servants* (2015), developed by Bastien de l’Hermite et al., makes explicit

the isomorphic parallels between the stochastic and combinatorial properties identified by Pietropaolo in the systemic structure of the *commedia dell'arte* and those of the operationally closed computer system.

166. As Clarke and Hansen put it, “a system is open to its environment in proportion to the complexity of its closure” (*Emergence and Embodiment*, 7). In relation to Mozart’s keyboard music, Holtmeier notes that its “‘closed’ forms are complex, both in themselves and in their connections with each other. . . . [Th ough] autonomy and isolation, Mozart’s blocks of material preserve an openness.” Holtmeier, “Reconstructing Mozart,” 322–23. Both despite and owing to the systematic specificity of Mozart’s notation, it continues to require the sensitive input of its current environment—which is to say readers, performers, and listeners—to be realized: see, for instance, Guymer, “Eloquent Performance,” 585–95.

167. In this context, it is significant that Caillois launched his definition of *mimicry* with the observation that play involved the temporary acceptance of “un univers clos, conventionnel et, à certain égards, fictif.” Caillois, *Les jeux et les hommes*, 60.

168. Spitzer, “A Metaphoric Model of Sonata Form,” 224. Spitzer’s theory can be considered in light of Condillac’s claim that *signes institués* evolved from *signes naturels* and Giambattista Vico’s insistence on the interdependence of rhetoric, sensation, invention, and recognition: see Rumph, *Mozart and Enlightenment Semiotics*, 32–33 and 81–107; and Rumph, “Topical Figurae,” 503–6. For complementary perspectives, see Diderot, *Lettre sur les sourds et muets*, 373–74; and Luhmann, *Art as a Social System*, 261.

169. On the (post)ideological implications of “classes” and other markers of identity in digital games, see Galloway, *Gaming*, 85–106; and Galloway, “*StarCraft*, or, Balance.”

170. August Wilhelm Schlegel, *Kritische Schriften und Briefe*, 5:247; translation in Esterhammer, *Romanticism and Improvisation*, 133.

171. On Gottsched’s insistence on the legibility and consistency of character, which comes ironically close to evoking the stock figures of the *commedia dell’arte*, see Mirka, *The Oxford Handbook of Topic Theory*, 7. On Hegel’s linkage of internal and external markers of identity, see Key 2–3, note 169.

172. Friedrich Schlegel, quoted and translated in Landgraf, *Improvisation as Art*, 84.

173. Caillois, *Les jeux et les hommes*, 64 (*Man, Play and Games*, 21). In the context of theatrical play, Richard Schechner configu es this paradox as a “double negative”: “a performer experiences his own self not directly but through the medium of experiencing the others. While performing, he no longer has a ‘me’ but has a ‘not not me.’” Schechner, *Between Theater and Anthropology*, 112; see also Pearce’s discussion in “Role-Play, Improvisation, and Emergent Authorship”; and Key 3–2, note 133.

174. Diderot, *Paradoxe sur le comédien*. Kramer reads this text in the light of C.P.E. Bach’s late keyboard music: “the actor shutting himself up inside that ‘great basket-work figure of which he is the soul’ is now the player at the keyboard. Reading for the sensibilities of Bach’s music, the dispassionate performer must now put on the masks figured in Bach’s script—and must then convince us that we are hearing not the player in mask but rather the beating heart of the music and its living soul.” Kramer, “Diderot’s *Paradoxe* and C.P.E. Bach’s *Empfindung*,” 24.

175. Mirka, *The Oxford Handbook of Topic Theory*, 2: the formulation echoes that of Michel Paul Guy de Chabanon, who found musical mimesis acceptable only when “one

melody [is given] the character of another melody” (quoted and translated in Allanbrook, *The Secular Commedia*, 106).

176. See, for instance, Wheelock, *Haydn's Ingenious Jesting with Art*; Taruskin, *The Oxford History of Western Music*, 2:539–42; Hunter, “Topics and *Opera Buffa*,” 74–75; Rumph, *Mozart and Enlightenment Semiotics*, 102; Chua, *Absolute Music and the Construction of Meaning*, 209–17; and Ivanovitch, “The Brilliant Style,” 348–49.

177. See Hertz, “Goldoni, *Opera Buffa*, and Mozart's Advent in Vienna,” 48–49.

178. According to the *Allgemeine musikalische Zeitung*, Bassi was known to mock the shortcomings of his fellow singers by way of subtle *mimicry*: “When he is in a mischievous mood he will . . . parody the faults of the other singers so exquisitely that only the audience, not the singers, are aware of it.” Quoted and translated in Abert, *Mozart's “Don Giovanni,”* 15.

179. See Schmidt, “Komponieren als intellektuelles Spiel.” On the tactic of recursive framing within *opera buffa*, see Hunter, “Topics and *Opera Buffa*,” 82–84. Excerpts from *Figaro* had themselves been freely adapted as different types of dance music, as Mozart reported to Gottfried von Jacquin (January 15, 1787, in *Briefe*, 4:10), while Mozart repurposed “Un bacio di mano,” an aria he had written to be inserted in Pasquale Anfossi's *opera buffa* *Le gelosie fortunate*, for the first movement of the “Jupiter” Symphony: see Knepler, *Wolfgang Amadé Mozart*, 229–30.

180. On Tieck's self-consciously recursive dramatic devices, conspicuously on display throughout the *commedia*-influenced *Die verkehrte Welt* (1798), see Landgraf, *Improvisation as Art*, 87–91.

181. Gjerdingen, *Music in the Galant Style*, 116. In this sense, Gjerdingen echoes Michaelis's stress on the importance of “mutually functional relations” over a merely “mechanical compositional process”: see Key 3–1, note 48.

182. Gjerdingen, *Music in the Galant Style*, 116.

183. Sutcliffe, review of Gjerdingen, *Music in the Galant Style*, 472.

184. From a different perspective, Allanbrook made an analogous point on the “superfluous layer of anthropomorphizing reference” with which analysts have approached the first movement of Mozart's Keyboard Sonata in F, K. 332/300k (*The Secular Commedia*, 117). See also Cook, *Beyond the Score*, 108–9; and Rumph, *Mozart and Enlightenment Semiotics*, 36–37.

185. See Key 2–5, notes 224–26; and Landgraf, *Improvisation as Art*, 40–41.

186. See Maturana and Varela, *Autopoiesis and Cognition*.

187. See, for instance, the various approaches to this issue taken by the essays in Clarke and Hansen, *Emergence and Embodiment*.

188. Landgraf, *Improvisation as Art*, 7–13 and 57–59.

189. Quoted and translated in *ibid.*, 66. Goethe was specifically referring to opera.

190. *Ibid.*, 66–68: see also Luhmann, *Art as a Social System*, 201–7.

191. Landgraf, *Improvisation as Art*, 44.

192. Holtmeier, “Reconstructing Mozart,” 307.

193. In this spirit, John Irving describes the opening of Mozart's Keyboard Sonata in C, K. 279/189d as “a texted version of something spontaneous” (*Understanding Mozart's Piano Sonatas*, 78).

194. “Improvisiren . . . kann sehr oft für den Tonsetzer ein Mittel werden, die Thätigkeit seines Genies zu reitzen, oder sich in denjenigen Zustand zu versetzen, den man die Begeisterung nennet.” Koch, *Musikalisches Lexikon*, s.v. “Improvisiren.”

195. See Key 1–0, notes 20–25.

3–4 THE CASE OF WINKEL'S COMPONIUM

196. Niedt, *The Musical Guide*, 96.
197. See Key 5–5, note 179.
198. On Kempelen's chess-playing "automaton," see Standage, *The Turk*.
199. See Key 3–1, note 34.
200. Ord-Hume, *Barrel Organ*, 188: Ord-Hume was citing a comment made by Douglas Berryman. For examples of contemporaneous expressions of incredulity, see Van Tiggelen, *Componium*, 70 and 77.
201. Quoted in Van Tiggelen, *Componium*, 66. On the construction, operation and subsequent deterioration of Winkel's Componium, see also Lyr, "Une merveille de mécanisme."
202. "Le *Componium* était doué de la faculté d'improviser des variations toujours nouvelles, d'un effet souvent très-heureux et toujours correct, sur un thème donné." Fétis, "Winkel (Diederich ou Thie ry Nicolas)," 477.
203. "Il suffisait de noter sur des cylindres divisés par tranches, le thème et quelques variations convenablement disposées d'après un système analogue à ceux que Kirnberger, Mozart, Fiedler, Calegari et d'autres ont imaginés pour composer de la musique par des jeux de dez, de cartes, de domino, etc." *Ibid.*, 477: this connection was first noted by the anonymous writer of a letter to the *Moniteur universel* in 1824, quoted in Van Tiggelen, *Componium*, 70.
204. Jean-Baptiste Biot and Charles Simon Catel, report published in the *Journal des débats politiques et littéraires*, February 7, 1824, quoted in Van Tiggelen, *Componium*, 71.
205. The concept of the technological sublime has been applied to Nancarrow's player-piano music by Eric Drott ("Conlon Nancarrow and the Technological Sublime"). Winkel's componium might offer a way of bridging the "wide historical gulf" that Drott perceives to separate "Burkean and Kantian notions of the sublime" in nature from the "palpably mechanical nature of Nancarrow's studies [in which] their sublimity resides" (*ibid.*, 545 and 547). Such a lineage could be traced further back to Mozart's music for mechanical organ and what Richards describes as its "highly artful game of combination and permutation" that evokes the "contrapuntal and mechanical sublime" ("Automatic Genius," 367 and 389). In this regard, it is notable that, when configured as a nonimprovising orchestrion, the componium counted the overture to *Die Zauberflöte* among its cylindrical repertoire: see Van Tiggelen, *Componium*, 199.
206. Biot and Catel, quoted in Van Tiggelen, *Componium*, 71. Such thought experiments were not novel: in 1758, for example, Jacob Adlung had calculated the registral possibilities afforded by an organ with twenty stops to number 1,048,575, which would provide 1,048 years' worth of chorales (cited in Eckert, "Ars Combinatoria," 73–74). The scale of the componium's permutational possibilities set new standards, however. Victor-Charles Mahillon calculated that the componium could generate new musical combinations for 138 trillion years (cited in Lyr, "Une merveille de mécanisme," 17), although Jim Bumgardner recently downsized this estimate to a mere 256,259,425 years ("Variations of the Componium").
207. Landgraf, *Improvisation as Art*, 57–59.
208. See Key 3–1, note 66.
209. See Van Tiggelen, *Componium*, 201.
210. On Mahillon's account, see Lyr, "Une merveille de mécanisme," 17–21. For a comprehensive technical account of the componium's design, manufacture, and operation, see Van Tiggelen, *Componium*, 263–339.

211. On von Foerster's distinction between trivial and nontrivial machines, see *The Beginning of Heaven and Earth Has No Name*, 19–23. The reordering of the componium's digital code by way of rotating cylinders anticipates the cryptographic mechanisms of twentieth-century rotor cipher machines such as the Enigma and Lorenz *Schlüsselzusatz* series: see Key 2–4, note 205.

212. Van Tiggelen, *Componium*, 315.

213. Abbate, *In Search of Opera*, 204. The componium's ingenious manipulation of physical phenomena can be related to another of Winkel's musical inventions, the function of which was diametrically opposed to that of aleatoric unpredictability: the "chronometer" (1814) was designed to beat regular time owing to its double-weighted pendulum. Winkel alleged that Maelzel purloined the idea before rebranding the invention as the "metronome," and it is in light of this bitter dispute that the componium has been construed as a retaliatory attempt to upstage Maelzel's "panharmonicon": see Van Tiggelen, *Componium*, 52–64; and Key 2–5, note 265.

214. See Van Tiggelen, *Componium*, 254–59.

215. Quoted in *ibid.*, 67.

216. Quoted in *ibid.*, 83.

217. Quoted in *ibid.*, 70.

218. Schilling, *Encyclopädie der gesamten musikalischen Wissenschaften*, 4:651–52.

219. Trippett, *Wagner's Melodies*, 96–97: see also Key 1–4, note 212.

220. See Yearsley, *Bach and the Meanings of Counterpoint*, 180. On the demotion of calculation from index of intelligence to mindless mechanism, see Riskin, "The Defecating Duck," 628–30.

221. See Key 2–2, notes 135–36.

222. See Szendy, *Listen*, 79: on analogous issues in the context of US law, see Gitelman, "Media, Materiality, and the Measure of the Digital"; and Suisman, *Selling Sounds*, 152–77.

223. Gooley, "Saving Improvisation."

224. *Ibid.*; Gjerdingen, *Music in the Galant Style*, 479–80. On the technologies through which musical works were mediated and their impact on improvisatory praxis, see also Caporaletti, "Ghost Notes," 370–75.

225. See Davies, *Romantic Anatomies of Performance*, 121–22.

226. Luhmann, *Art as a Social System*, 89.

227. See Key 1–0, notes 35–43.

228. Smith, *Divine Machines*, 197–231: see also Key 3–1, note 32.

229. Smith, *Divine Machines*, 230.

230. *Ibid.*

231. "Die Natur fängt mit dem Menschen nicht besser an als mit ihren übrigen Werken: sie handelt für ihn, wo er als freie Intelligenz noch nicht selbst handeln kann. Aber eben das macht ihn zum Menschen, daß er bei dem nicht stille steht, was die bloße Natur aus ihm machte, sondern die Fähigkeit besitzt, die Schritte, welche jene mit ihm antizipierte, durch Vernunft wieder rückwärts zu thun, das Werk der Not in ein Werk seiner freien Wahl um-zuschaffen und die physische Nothwendigkeit zu einer moralischen zu erheben." Schiller, *Briefe über die ästhetische Erziehung des Menschen*, 5.

232. Smith, *Divine Machines*, 348n89.

233. Derrida, "Psyche," 48, quoted and glossed in Landgraf, *Improvisation as Art*, 27.

234. Derrida, "Psyche," 61.

235. Landgraf, *Improvisation as Art*, 31-34; Gallope, "Is Improvisation Present?" See also Peters, *The Philosophy of Improvisation*, 145-70.

236. Luhmann, *Art as a Social System*, 204 and 194.

237. *Ibid.*, 194.

238. See Key 3-3, note 189.

239. As Bumgardner notes, the mechanism of the *componium* was not entirely random: not only did the sequence of its variations have to proceed by step, but the physical imperfections of its components were almost certain to skew the probability of its roulette wheels selecting one outcome over another ("Variations of the *Componium*").

240. Luhmann described the mixture of improbability and facticity that activates hermeneutical feedback loops: "When focusing on the improbability of form itself, one is primarily concerned with the observer's fascination, his staying-put-with-the-work in a sequence of observations that attempt to decipher it." Luhmann, *Art as a Social System*, 126.

241. On the relationship between the sublime and the banal, see Shinkle, "Videogames and the Digital Sublime," 98-99.

242. See Van Tiggelen, *Componium*, 208-19.

243. Balzac associated the *maisons à musique* at which instruments such as the *componium* were exhibited with moral laxity and adulterous temptation: see Van Tiggelen, *Componium*, 78-79. Established by Adolph and Arthur Caille, whose father Joseph was a Swiss cabinetmaker, the Caille Company was renamed the Caille Bros. Company in 1901: in both guises, it produced a wide variety of slot machines. By excavating the sites and operational principles of such machines, Erkki Huhtamo adopts an archaeological perspective on arcade gaming that casts new (and old) light on the social, historical, and media-technical facets of late-twentieth-century arcades ("Slots of Fun, Slots of Trouble").

244. In catalogs listing slot machines such as *la reliable*, music boxes were often advertised as an optional means of circumventing legal obstacles by transforming them from gambling devices into sources of entertainment. Depending on the prevailing legislature, the (more or less) arbitrary stopping point of *la reliable*'s roulette wheel could indicate a horoscope instead of a pecuniary outcome. I am grateful to Jean-Claude Baudot for this information: see his *Machines à sous*, 19-21.

245. For a technical exposition of information theory, see Shannon and Weaver, *The Mathematical Theory of Communication*. On its historical, critical, theoretical, and ideological repercussions, see Geoghegan, "From Information Theory to French Theory"; Liu, *The Freudian Robot*, 45-50; and Mills, "Deaf Jam," 50-51.

3-5 THE INVISIBLE THUMB ON THE SCALE

246. Meier and Briggs, instruction manual for *Sid Meier's C.P.U. Bach*, 21. The manual also includes background information on "Music in the Age of Bach" (14-15) and the Niedtian range of forms (Prelude and Fugue, Concerto, Dance Suite, Sonata, Chorale, Chorale Prelude, Fantasia, and Chaconne) in which the software can "improvise" (16-18).

247. On Diderot's thought experiment, see Key 2-5.

248. Meier and Briggs, instruction manual for *C.P.U. Bach*, 16.

249. On the applicability of Markov chains to processes of musical generation, see Nierhaus, *Algorithmic Composition*, 67-82.

250. Meier et al., “System for Real-Time Music Composition and Synthesis,” 13:3–B. *C.P.U. Bach*’s rules and tendencies are described in its patent. Both types of protocol encode Fuxian behavior: “leaps of a fifth are always followed by a step back” (6:33–34), while “small steps” are favored over “large skips” (7:25).

251. See Key 2–2, notes 126–28.

252. These algorithmic steps are sequentially presented in Meier et al., “System for Real-Time Music Composition and Synthesis,” 19–22.

253. On the intellectual context of Thomas Bayes’s influential work on probability, see Daston, *Classical Probability in the Enlightenment*, 253–67.

254. Meier et al., “System for Real-Time Music Composition and Synthesis,” 7:27.

255. Quoted and translated in Daston, *Classical Probability in the Enlightenment*, 270–71. In many cases, the weight of the invisible thumb could be reliably adjusted, whether manually or automatically: in an anonymous and undated Caille Bros. Company catalog, the “Detroit” machine is said to incorporate “a clever percentage device inside that regulates earnings” (25).

256. Meier discusses *C.P.U. Bach* in Michael Lawrence’s film *Bach and Friends* (2010).

257. On the politics of *Civilization*, see Friedman, “*Civilization* and Its Discontents”; and Galloway, *Gaming*, 90–103. On how these politics play out in its soundtrack, with which Briggs was closely involved, see Cook, “Music, History, and Progress in *Sid Meier’s Civilization IV*.”

258. Galloway, *Gaming*, 102.

259. *Ibid.*, 103; see also Winnerling, “The Eternal Recurrence of All Bits.”

260. See Key 2–4, note 213; and Key 3–3, note 172.

261. The construction and operation of Kircher’s *organum mathematicum* was described by Schott in his book of the same title (1668).

262. Pias, “The Game Player’s Duty,” 179; see also Key 2–1, note 49.

263. Wiener, *Cybernetics*; Liddell and Scott, *A Greek-English Lexicon*, s.v. κυβερνάω.

264. Such “dancing” and its romantic rewards bring the mechanical movements of *la musicienne* to mind, which mimed the very means by which “the subject finds and experiences itself,” as Voskuhl puts it (*Androids in the Enlightenment*, 163).

265. Gilbert-Rolfe, *Beauty and the Contemporary Sublime*, 142.

266. See Key 2–5, note 224.

267. See Key 2–5, note 238. Rumph invokes Smith’s writings on instrumental music to elucidate the playful processes by which “musical subjects take shape” within the “Smithian machine” of Mozart’s Keyboard Concerto in B flat, K. 450 (*Mozart and Enlightenment Semiotics*, 137 and 123). Despite the “musical dice games” and the arbitrary “play of colors and textures” that animate the Andante (*ibid.*, 125), the last movement inexorably homes in on a *lieto fine* in which “instruments and material find their proper alignment” (*ibid.*, 137), reaffirming the premises which its predecessors had seemed to call into question.

268. See Key 2–5, note 240.

269. See Key 1–5, note 270.

270. This aligns with Nowvickie’s formulation of the “ludic algorithm”: “What may look inaccessible, mechanistically algorithmic . . . might be better understood as a ludic algorithm, which I posit as a constrained, generative design situation, opening itself up—through performance by a subjective, interpretive agent—to participation, dialogue, inquiry, and play within its prescribed and proscriptive ‘computational spaces.’” Nowvickie, “Ludic Algorithms,” 158–59.

271. I refer here to Bateson's famous formulation: see Key 2–1, note 71.

272. Goehr, "Improvising *Impromptu*": see also Key 1–5, note 253.

273. Goehr, "Improvising *Impromptu*."

274. On the emergence of second-order cybernetic theory, its observations on information theory as codified by Shannon, and its impact on the intellectual programs of Luhmann and Kittler, see Winthrop-Young, "Silicon Sociology," 408–17; and Key 3–1, note 25.

275. It is an axiom of Luhmann's systems theory that all observers have their blind spots, one from which I claim no exemption. In a recursive echo of Hayes's and Burney's unconscious mimesis, I was unaware when setting out on this Key that my invocation of the Literary Engine mimicked not only their but also Liu's (*The Freudian Robot*, 39–42) and Nowwiskie's ("Ludic Algorithms," 139–40) rhetorical strategy of embedding it at the beginning of an essay.

276. See Key 5–5, note 181 see also Ingold, *Being Alive*, 216.

KEY 4 HIGH SCORES: WAM VS. LVB

1. On Mozart's Zoroastrian riddles and their Masonic overtones, see Solomon, *Mozart*, 337–52.
2. Mozart wrote four puzzle canons ca. 1770–72: on Mozart's canonical activities in general, see Zaslaw and Cowdery, *The Complete Mozart*, 98–105.

3. Holtmeier, "Reconstructing Mozart," 307; see also Rosen's similar sentiments as articulated in "Tradition without Convention."

4. Byros, "Trazom's Wit."

5. Holtmeier, "Reconstructing Mozart," 309.

6. Holtmeier quotes Adorno's observation of the "riddle character [*Rätselcharakter*]" that attends Mozart's "autonomous blocks of material." *Ibid.*, 308.

7. See Key 5–5, note 182.

8. As Klorman points out in the context of Mozart's social music-making, sight-reading a score can itself afford a pleasurable extemporaneous challenge that exposes and develops a musician's qualities as composer as well as performer (*Mozart's Music of Friends*, 86–104).

9. Butt, "Towards a Genealogy of the Keyboard Concerto."

10. *Ibid.*, 93–98.

11. On the keyboard as medium in this sense, see Plebuch, "Öffentlichkeit und Musikalienmarkt im Zeitalter Cal Philipp Emanuel Bachs," 197–201; see also Key 2–3, note 192.

12. See Huhtamo, "Dismantling the Fairy Engine: Media Archaeology as Topos Study." On topical discourse in studies of eighteenth-century music, see Ratner, *Classic Music*; Allanbrook, *Rhythmic Gesture in Mozart*; Agawu, *Playing with Signs*; and Mirka, *The Oxford Handbook of Topic Theory*.

4–1 UNSETTLED SCORES

13. Hoffmann, "Johannes Kreisler's Certificate of Apprenticeship," 192.

14. See Abbate, "Music—Drastic or Gnostic?"; and Gumbrecht, *Production of Presence*, 54–64.

15. Cook, *Beyond the Score*, 2.

16. On the implications of this privilege and how it might be countermanded via somatic performance, see *ibid.*, 308–36; and Taylor, *The Archive and the Repertoire*.

17. Gumbrecht, *Production of Presence*, 14. Gumbrecht's formulation, drawn from his description of the impact of an epiphanic moment emerging from aesthetic experience, echoes Hegel's definition of a musical tone as "ein Daseyn, das verschwindet, indem es ist": see Key 2-1, note 69.

18. Moten, "The Phonographic *Mise-en-Scène*," 269–70.

19. Adorno, *Towards a Theory of Musical Reproduction*, 182; see also Key 5-0, note 6.

20. Adorno, *Towards a Theory of Musical Reproduction*, 59–74.

21. *Ibid.*, 57–63.

22. *Ibid.*, 62–63.

23. *Ibid.*, 182–86.

24. *Ibid.*, 74; see also Newman, "Beethoven's Fingerings as Interpretive Clues," and Anton Kuerti's discussion of Beethoven's ambiguous fingerings in the introduction to his edition of Franz Kullak's *Beethoven's Piano Playing*, xvi–xviii.

25. On the ambiguities and paradoxes of nineteenth-century notation, see Poli, *The Secret Life of Musical Notation*; Kim, "The Brahmsian Hairpin"; and Rowland, "Piano Notation in Chopin and Liszt's Paris." On the role of the pedal in particular, see Hiebert, "Listening to the Piano Pedal"; Helyard, "To Prevent the Abuse of the Open Pedal"; and Rowland, "Piano Notation in Chopin and Liszt's Paris," 17–20. Busoni described the pedal as "an inimitable device, a picture of the sky, a ray of moonlight" that mitigated "the impossibility of sustaining the [piano's] sound and the pitiless, sharp division of the keyboard into unalterable half-tones." Busoni, *The Essence of Music*, 79; see also Key 1-5, note 249; and Key 2-5, note 252.

26. Scott de Martinville, *Phonographic Manuscripts*, 24.

27. Adorno, "The Form of the Phonograph Record," 279–80; see also *Towards a Theory of Musical Reproduction*, 179–86; and Key 5-2. On the genealogy of "writing without a subject," see Kittler's reading of Rainer Maria Rilke's essay "Primal Sound" in *Gramophone, Film, Typewriter*, 38–50.

28. Throughout *Towards a Theory of Musical Reproduction*, Adorno repeatedly returns to the theme of musical reproduction as the copying of a nonexistent original: see, for instance, pp. 183, 202, and 218.

29. On the influence of this historiographical narrative, see Butt, *Playing with History*, 102–6.

30. Moroney, "The Performance of Unmeasured Harpsichord Preludes," 145; see also Troeger, "Metre in Unmeasured Preludes."

31. Moroney, "The Performance of Unmeasured Harpsichord Preludes," 147–51; see also Chung, "The *Port de Voix* in Louis Couperin's Unmeasured Preludes."

32. Butt, *Playing with History*, 106.

33. Moroney, "The Performance of Unmeasured Harpsichord Preludes," 151; see also Key 3-1, note 63.

34. On d'Anglebert's notation, see Moroney, "The Performance of Unmeasured Harpsichord Preludes," 150.

35. For a Schenkerian consideration of how large-scale voice-leading strategies can be conceived to underpin Couperin's dance pieces, see Pershing, "Levels of Voice Leading in the Music of Louis Couperin."

36. On Riepel's *monte*, see Lester, *Compositional Theory in the Eighteenth Century*, 267–70; and Gjerdingen, *Music in the Galant Style*, 89–106. On the "Meyer," see Gjerdingen, *Music in the Galant Style*, 111–8.

37. Luhmann, *The Reality of the Mass Media*, 109. For alternative perspectives on schemata, see Gjerdingen, *Music in the Galant Style*, 10–16; and Descola, *Beyond Nature and Culture*, 107–111.

38. Klorman makes an analogous connection between Mozart's extemporized realization of his Sonata for Keyboard and Violin in G, K. 379/373a, discussed in Key 4–2, and Schenkerian precepts (*Mozart's Music of Friends*, 104n90).

39. Quoted and translated in Rink, "Schenker and Improvisation," 2.

40. Quoted and translated in *ibid.*, 3; Lester, *Compositional Theory in the Eighteenth Century*, 262–63. On Schenker's appreciation of C.P.E. Bach and the fundamental importance of thoroughbass principles vis-à-vis Schenker's analytical method, see Schenker, *The Art of Performance*, 70–71; Brown, "C.P.E. Bach, Schenker, Improvisation, and Composition"; Christensen, "Thoroughbass as Music Theory," 35–36; and Richards, *The Free Fantasia and the Musical Picturesque*, 42–45.

41. See Key 3–1, *note* 50.

42. See Key 5–5, *note* 183.

43. To the extent that these premises are rendered audible, Adorno dubs them "idiomatic": in the course of performance, the "idiomatic component is the sole condition for concretion." Adorno, *Towards a Theory of Musical Reproduction*, 56.

44. Leech-Wilkinson, "Compositions, Scores, Performances, Meanings," [5.3].

45. Gjerdingen, *Music in the Galant Style*, 141–55. Gjerdingen's schematic presentation of the *cadenza composta* synthesizes elements from various Neapolitan traditions. As Di-ergarten points out with reference to Giovanni Maria Bononcini's pronouncements (1673), the defining feature of the *cadenza composta* is the creation of dissonance, typically via the suspension of the tonic in an upper voice over the fourth or fifth scale degree in the bass, creating a 6/5, 5/4, or 6/4 sonority that requires resolution in accordance with concomitant metrical and melodic implications ("Beyond 'Harmony,'" 65–70). Each of the three variants in Example 2 is a *cadenza di salto* insofar as its bass leaps from the penultimate pitch to the final destination. For supplementary definitions and further discussion of terminological issues relating to such *cadenze*, see Sanguinetti, *The Art of Partimento*, 105–10.

46. On the *cadenza finta* in the *partimento* tradition and beyond, see Key 4–2, *note* 74; on the rise of the *cadenza*, see Whitmore, *Unpremeditated Art*; and on Mozartian ploys and decoys in the context of the *cadenzas* he wrote for his keyboard concertos, see Mirka, "The Cadence of Mozart's *Cadenzas*."

47. See, for instance, Stadler, *Tabelle, aus welcher man unzählige Menueten und Trio für das Klavier herauswürfeln kann*, when mm. VI, VII, and VIII of the minuet are concatenated from mm. 2, 36, and 91.

48. See Gumbrecht, *Production of Presence*, 64. Even Adorno accorded the "last word" on the matter of performance to "common parlance, in which music is 'made.'" Adorno, *Towards a Theory of Musical Reproduction*, 183.

4-2 MOZART'S TWO-PLAYER GAMES

49. The *cadenza composta di salto* appears in the first and third systems; in the latter instance, it is chromatically elaborated. In the terminology of Gjerdingen's schemata, the fantasia opens with a Romanesca and closes with a *quiescenza* (on which see *Music in the Galant Style*, 25–43 and 181–95, respectively).

50. Quoted and translated in Moroney, "The Performance of Unmeasured Harpsichord Preludes," 145.

51. "C'est sur-tout en préludant, que les grands Musiciens, exempts de cet extrême asservissement aux règles que l'œil des critiques impose sur le papier, font briller ces Transitions savantes qui ravissent les Auditeurs." Rousseau, *Dictionnaire de musique*, s.v. "préluder."

52. Mozart to Leopold and Maria Anna Mozart, July 20, 1778, in *Briefe*, 2:410–11 (translation in Anderson, *Letters*, 2:573–74).

53. Nannerl specifically asked Wolfgang for a prelude that modulated from C to B flat; see her postscript to Leopold's letter of September 28–29, 1777, in *Briefe*, 2:20.

54. Levin, "Mozart's Non-Metrical Keyboard Preludes," 215.

55. Bach, *Versuch über die wahre Art das Clavier zu spielen*, 2:335.

56. See Gjerdingen, *Music in the Galant Style*, 163; and Whitmore, *Unpremeditated Art*, 3–34. Across Europe, the parsing of the cadential 6/4 chord as consonance or dissonance varied in accordance with locally prevailing theoretical norms. In distinction to Neapolitan *partimentisti*, for whom the 6/4 chord was always dissonant (see Key 4-1, note 45), Mozart's treatment of the 6/4 chord as a launch pad for extended passagework reflected his own pedagogical representation of it as an *accordo di quarta consonante* and thus an inversion of the tonic triad, as Mirka points out ("The Cadence of Mozart's Cadenzas," 298–99).

57. Leopold Mozart to Mozart, August 13, 1778, in *Briefe*, 2:446; translation in Anderson, *Letters*, 2:600.

58. See note 52 above.

59. The terms "prescriptive" and "transcriptive" were applied to notation by Charles Seeger ("Prescriptive and Descriptive Music-Writing"). Although Mozart claimed on occasion to have composed a piece "in his head" before writing it down (see, for instance, his letter to Maria Anna Mozart of April 20, 1782, in *Briefe*, 3:202, and notes 61 and 66 below), when working on his keyboard concertos he seems to have moved between keyboard, *particella*, and orchestral draft: see Levin, "Mozart's Working Methods in the Keyboard Concertos"; Keefe, "'We Hardly Knew What We Should Pay Attention to First,'" 195; and Zaslav, "Mozart as a Working Stiff," 110.

60. Mozart to Leopold Mozart, April 24, 1784, in *Briefe*, 3:311 (translation in Spaethling, *Mozart's Letters*, 367–68. Leopold shared his son's high opinion of Strinasacchi: see his letter to Maria Anna Mozart of December 7, 1785, in *Briefe*, 3:467).

61. See Deutsch, *Mozart*, 497–501.

62. Mozart to Leopold Mozart, April 8, 1781, in *Briefe* 3:108; translation in Spaethling, *Mozart's Letters*, 240. On the conditions of this performance, see Klorman, *Mozart's Music of Friends*, 103–4.

63. Perhaps unsurprisingly, the sonata's autograph reveals that the extreme economy of its initial sketching cost Mozart more time and trouble at a later date: in the course of writing out the keyboard part, he made alterations to the violin part.

64. Breene, "Mozart's Violin Sonatas and the Gestures of Embodiment."

65. These opening gestures represent a less obvious alternative to the C-major arpeggio with which Mozart initially toyed: see Figure 56.

66. Hertzmann, "Mozart's Creative Process," 20.

67. See Key 3–2, note 112.

68. See Key 3–2, notes 84–88. Insofar as only the first violin part of Mozart's pantomime music survives, its score now exists in the state from which K. 454 was purportedly performed.

69. The tale is recounted in Dittersdorf, *The Autobiography of Karl von Dittersdorf*, 81–85. According to Czerny, the young Beethoven often improvised "[in] the first movement form or the final rondo of a sonata" (quoted and translated in Thayer, *Thayer's Life of Beethoven*, 1:368).

70. Gjerdingen, *Music in the Galant Style*, 10.

71. On the *clausula vera* and *clausula perfectissima*, see *ibid.*, 164–65 and 139–40. In m. 8, the dissonance characteristic of the *cadenza composta* results from the displaced prolongation of E flat (which shifts octaves halfway through the measure), creating a 7/5/3 harmony over the octave F_{2+3} in the keyboard's left hand.

72. It seems unlikely that passages involving enharmonic modulations such as those in the central Andante (mm. 59–67) would have been extemporized.

73. On the application of athletic imagery to such precadential passages, see Ivanovitch, "Showing Off," 183n7.

74. See Gjerdingen, *Music in the Galant Style*, 150: on such cadential deceptions, see also Sanguinetti, *The Art of Partimento*, 111–12 and 270–73; Neuwirth, "Fuggir la Cadenza"; Caplin, "The Classical Cadence"; and Schmalfeldt, "Cadential Processes." Structurally, this passage is closely analogous to that which ends the melancholic second movement (mm. 147–70) of Mozart's earlier Sonata for Keyboard and Violin in E minor, K. 304/300c (1778).

75. On the gendered implications of Mozart's K. 454 in the context of its performance by Strinasacchi, see Breene, "Mozart's Violin Sonatas and the Gestures of Embodiment," 222–63.

76. On Mozart's predilection for rhyming, see Key 4–3, notes 135–36.

77. On the systematic unfairness of fair play, see Key 2–4, notes 197–98.

78. See Key 1–1, note 84.

79. Hutchings, "The Keyboard Music," 56.

80. Einstein, *Mozart*, 273.

81. On the historical, aesthetic, and financial currency of the balance ascribed to Mozart's music throughout the nineteenth and twentieth centuries, see Chua, "Myth," 207–10.

82. William Kinderman describes the first keyboard's acciaccaturas in mm. 35, 37, and 39 of the first movement as "cute winks" (*Mozart's Piano Music*, 102).

83. See, for example, what passes for the "development" section in the first movement (mm. 81–110) which bears no thematic resemblance to the exposition: instead, it consists of successive attempts to probe the imitative and affective potential of a *partimento*-like melody. On the notions of "replay," "counterplay," and "coplay," see Kerman, *Concerto Conversations*, 42–44.

84. Abert, *W.A. Mozart*, 889; see also Key 5–5, note 184.

85. "Mozart, Sonata for Two Pianos, K. 448, first movement," visualized by Stephen

Malinowski and performed by Paavali Jumppanen and Elaine Hou ([youtube.com/watch?v=74Osn05UkU0](https://www.youtube.com/watch?v=74Osn05UkU0)). Jumppanen and Hou take playfully improvisatory liberties with the reiterations of Mozart's "cute winks" (see note 82 above).

86. Winternitz, "Gnagfl w Trazom," 207; see also Richards, "Automatic Genius." Winternitz acknowledges that since the source is Friedrich Rochlitz, the anecdote's veracity is dubious. That notwithstanding, composers such as Busoni, Hans Haass, Hindemith, and Nancarrow would proceed to demonstrate the method's viability when plotting music for the player piano: see Hocker, *Faszination Player Piano*, 205–305; and Key 5–2, note 96.

87. As Ivanovitch describes it, the overture to *Così fan tutte* "pushes a local recursive strategy to the limits of sense, combining and recombining thematic modules with bewildering capriciousness." Ivanovitch, "Recursive/Discursive," 163.

88. On the *monte principale*, see Gjerdingen, *Music in the Galant Style*, 97–102.

89. Durante, *Studio* no. 2, mm. 6–7 (1747), reproduced in Gjerdingen, *Music in the Galant Style*, 102. Mozart's deployment differs from Durante's insofar as the upper voice is a third higher, which brings it into closer canonic alignment with the lower voice.

90. It is conceivable that Mozart composed this mock-funereal music as sardonic commentary on the uneven standard of Ployer's counterpoint exercises.

91. Kinderman, *Mozart's Piano Music*, 103.

92. See Key 3–1, note 30.

93. On "Diffi lelectu," K. 59, and "O du eselhafter Peierl," K. 59a, see Zaslaw and Cowdery, *The Compleat Mozart*, 104–5. Both works testify to a malicious streak in Mozart that he himself acknowledged: "I just have to have somebody around I can make fun of," he wrote to Constanze (letter of June 25, 1791, in *Briefe*, 4:141; translation in Spaethling, *Mozart's Letters*, 434).

94. On *Bölzlschiessen*, see Bauer, *Mozart*, 73–116; Schroeder, *Mozart in Revolt*, 55–58; and Halliwell, *The Mozart Family*, 252–53.

95. On the FPS genre, see Key 2–4, note 206.

96. As Abert put it, "effect and counter-effect generally move in only one direction, complementing each other and extending each other's range of expression, even amending each other on points of detail, but never leading to irreconcilable dramatic tensions in which one or the other partner is gradually forced to lay down his arms." Abert, *W.A. Mozart*, 880; see also Klorman, *Mozart's Music of Friends*, 157. Similarly, cooperative players of games such as *Bubble Bobble* may squabble, mischievously impede each other, and compete for items and points, but as a rule such behavior does not undermine either player's fundamental commitment to their shared endeavor.

97. Mozart dismissed Clementi as a "Ciarlattano" as well as a "mechanicus" (letters to Leopold Mozart of June 7, 1783, and January 12, 1782, in *Briefe*, 3:272 and 191).

98. See Mozart's letters to Leopold Mozart of June 27 and August 22, 1781, in *Briefe*, 3:135 and 150–52. Despite—or perhaps owing to—his harsh criticism of Auernhammer's physical attributes and his denial of amorous feelings toward her, Mozart clearly held her in some affection. She was the dedicatee of six of his sonatas for keyboard and violin (K. 296 and 376–80) and she played the first keyboard part in the Sonata for Two Keyboards, which features an F sharp₆ peculiar to her instrument: see Levin's notes for *Music for Two Fortepianos* (Nonesuch 27P2–2808), a CD he recorded with Malcolm Bilson.

4–3 CONCERTED ACTION

99. Maria Theresia Paradis (on whom see Key 2–3, notes 180–81) was also Richter's pupil.
100. Mozart to Leopold Mozart, April 28, 1784, in *Briefe*, 3:312 (translation in Spaethling, *Mozart's Letters*, 368).
101. Mozart to Leopold Mozart, June 27, 1781, in *Briefe*, 3:135; translation in Spaethling, *Mozart's Letters*, 270. Mozart's opinion was shared by Viennese critics, as Cliff Eisen reports ("The Rise [and Fall] of the Concerto Virtuoso in the Late Eighteenth and Nineteenth Centuries," 187).
102. Mozart to Leopold Mozart, April 28, 1784, in *Briefe*, 3:312 (translation in Spaethling, *Mozart's Letters*, 368).
103. Barth, *Wolfgang Amadeus Mozart*, 47.
104. See Key 5–5, note 185.
105. See, for instance, Keys, "The Etymology of *Concerto*," in which "*conserto* (from the past participle of *conserere*, unite, join)" is accorded precedence (449).
106. Pietropaolo, "The Theatre," 19.
107. *Ibid.*, 19; see also Key 3–2, notes 98–103.
108. Koch quotes Sulzer's comments on the performability of the symphony: "Because it is not an exercise like the sonata but must be sightread, there must be no difficulties which cannot be confronted and clearly played at once by many." Koch, *Versuch einer Anleitung zur Composition*, 3:302; translation in Treitler, *Strunk's Source Readings in Music History*, 808. The vexed question of the role of the keyboard as continuo instrument in Mozart's concertos turns in part on such contingencies: see Eisen, "The Primacy of Performance."
109. See Levin, "Mozart's Working Methods in the Keyboard Concertos," 406. Mozart expressed his pleasure "when an aria is so accurately measured for a singer's voice that it fits like a well-tailored dress." Mozart to Leopold Mozart, February 28, 1778, in *Briefe*, 2:304; translation in Spaethling, *Mozart's Letters*, 135.
110. See Lorenz, "New and Old Documents Concerning Mozart's Pupils Barbara Ployer and Josepha Auernhammer," 3B–16.
111. On Mozart's double role as performer and composer of his concertos, see Keefe, "We Hardly Knew What We Should Pay Attention to First."
112. Levin, introduction to Mozart, *Klavierkonzert c-Moll, KV 491*, 3; Irving, *Mozart's Piano Concertos*, 235.
- 1B. See Key 3–1, note 50. Concertos that pose analogous issues include K. 451, K. 482, K. 488, and K. 537.
- 1A. As Levin puts it, the textu(r)al additions of performers "are most effective when they are fully organic to a work's expressive and dramatic content—indeed, when those without a score in front of them are unaware that anything has been added at all." Levin, "Instrumental Ornamentation, Improvisation and Cadenzas," 289. Caporaletti, by contrast, casts doubt on the desirability—and even the possibility—of reconstructing "an orally mediated text . . . by simply inverting the direction of the encoding process." Caporaletti, "Ghost Notes," 357–58.
- 1B. Levin hedges somewhat by advocating a brief pause on the B flat₄ "to lend psychological weight to the 6/4." Levin, "Critical Notes" to Mozart, *Klavierkonzert c-Moll, KV 491*, 7.
116. As Irving notes, "[occasionally], and perhaps deliberately, Mozart neglected to cancel one or other alternative layers of realization, resulting in passages for which no 'definitive' text ever emerged." Irving, *Mozart's Piano Concertos*, 236.

17. Levin, "Critical Notes" to Mozart, *Klavierkonzert c-Moll, KV 491*.
118. Knepler, *Wolfgang Amadé Mozart*, 246.
119. The term is Goehr's: see Key 3-5, note 272.
120. In Mozart's (in)famous letter to his cousin Maria Anna Thekla Mozart of November 5, 1777, the phrase "warum nicht?" appears no fewer than fifteen times (*Briefe*, 2:105). On the association of leaps with musical playfulness, see Pesic, "The Child and the Daemon," 96; Abbate, "Music—Drastic or Gnostic?," 511; and the discussion of Bizet's "Sauté-mouton" in Key 5-0.
121. Observing the schematic configuration of Mozart's precadential fireworks in the keyboard concertos, Abert describes the "scales shooting upwards like rockets on arching triads, allowing the staccato quavers to sink back to earth again like flares, followed by the crackle of the trill." Abert, *W.A. Mozart*, 883. On the kinesthetic pleasures and challenges of such motions and their choreography in accordance with the affordances and constraints of the keyboard, see Rushton, "Play or Compulsion?," 5; Key 3-2, note 110; and Sutcliffe, *The Keyboard Sonatas of Domenico Scarlatti*, 188-96 and 285-86.
122. Leon Plantinga's description of the "dive-bomber-like cadences" punctuating the first movement of Beethoven's Piano Concerto in C minor, op. 37, reflects the raw kineticism of such gestures (*Beethoven's Concertos*, 156).
123. Ivanovitch, "Showing Off," 189; 213; 185; 187; 90; and 214.
124. *Ibid.*, 202.
125. Concertos that open with such harmonic and melodic gambits include K. 271, K. 450, K. 466, K. 467, and K. 503. On the dialogical aspects of Mozart's concertos in the theoretical light (and shadow) cast by Koch, see Keefe, *Mozart's Piano Concertos*.
126. In conversation, Andreas Staier and Alfred Brendel described K. 459 as a "cheeky" concerto "designed along dancelike lines." Staier and Brendel, booklet accompanying Staier's CD *Mozart: Piano Concertos nos. 18 & 19* (Teldec 8573-80676-2), 3-4. On operational closure, see Key 1-3, note 185.
127. On the fractious attributes of the polyp and its relation to late-eighteenth-century music, see Allanbrook, *The Secular Commedia*, 2-8 and 23; see also her insightful discussion of K. 459's finale (140-46).
128. All these tactics invoke and evoke ambiguity between tonic and dominant: the opening theme fuses Gjerdingen's "Fenaroli" and Riepel's *ponte* schemata (on which see Gjerdingen, *Music in the Galant Style*, 225-40 and 197-215, respectively), while the converging cadence, a species of the *clausula cantizans*, "sets up the possibility for a modulation to the dominant key but does not guarantee that modulation." *Ibid.*, 160. On the fusion of the "Fenaroli" and *ponte*, see Byros, "Trazom's Wit." The dominant-leaning tendencies of Mozart's theme are highlighted by Haydn's deployment of similar material as an unambiguous *ponte* in the finale of his Symphony no. 78 in C minor (1782), mm. 48-56. It seems plausible that Mozart was aware of Haydn's symphony, especially bearing in mind the resemblance of the first movement's opening theme to that of K. 491: see Rifkin, "Ein unbekanntes Haydn-Zitat bei Mozart."
129. Mozart liberally deploys the rhythm in both metrical guises throughout the movement and sometimes overlays them, as in Figure 64, mm. 441-44: see also Allanbrook, "Comic Issues in Mozart's Piano Concertos," 93.
130. Quoted and translated in Grayson, *Mozart: Piano Concertos nos. 20 and 21*, 96.

131. On the various species of Romanesca, see Gjerdingen, *Music in the Galant Style*, 25–43.

132. Levy, “Contexts and Experience,” 146: her reading draws on observations made by Cuthbert Girdlestone. The brash call-and-response between keyboard and winds in mm. 486–96 evokes the “sassy trumpet call,” as Allanbrook describes it, at the corresponding juncture of the Keyboard Concerto in D minor, K. 466 (*The Secular Commedia*, 131).

133. Levy, “Contexts and Experience,” 146: word of Levy’s comic performance of her script reached me via James Webster, who was present at the conference from which her essay emerged. On a complementary reading of the ending of K. 459 as an instantiation of Zeno’s paradox, see Allanbrook, *The Secular Commedia*, 145; on Mozart’s games with Leutgeb, see Key 3–3, note 154.

134. Gaunt, *The Games Black Girls Play*, 186: see also Eve Harwood, “Go On Girl!,” and the diverse range of children’s ludomusical practices exhibited in Campbell and Wiggins, *The Oxford Handbook of Children’s Musical Cultures*.

135. See Leopold Mozart to Mozart, February 12, 1778, and Mozart’s reply of February 19, in *Briefe*, 2:273 and 286. This type of ludomusical practice has a long history that includes the *cinquecento* imitation games of Vecchi, in which singers imitate instruments such as the harpsichord (“dingu dengu la dingu”) as well as foreign languages and dialects: see Schleuse, *Singing Games in Early Modern Italy*, 200–211 and 212–26. See also the macaronic vocal quartet “Caro mio Druck und Schluck,” K. 571a (1789), the text of which consists of phrases in high-flown Italian *alla opera seria* juxtaposed and interwoven with Hanswurstian crudities in Viennese dialect. I am grateful to Neal Zaslaw for bringing this piece to my attention.

136. Mozart to Gottfried von Jacquin, January 15, 1787, in *Briefe* 4:11; see also Mozart to Maria Anna Thekla Mozart of November 5, 1777, in *Briefe*, 2:104–6, and the cast list of Mozart’s *Hanswurstiade Die Liebesprobe* (see Key 3–2, note 83), which features a witch named Slinzkicotinzi. On the basis of what he identifies as letters indexing musical excerpts that also compose Franziska von Jacquin’s name via an algorithmic and combinatorial process, Hideo Noguchi has argued that Mozart’s enigmatic Musical Game in C, K. Anh. 294d/516f was devised with the von Jacquin family in mind (“Mozart”: see also Zaslaw, “Mozart’s Modular Minuet Machine,” 227–30).

137. Mozart adapted the text for his canon from another planned *Hanswurstiade*, *Der salzburger Lump in Wien*: Freystädler was identified with the eponymous rogue (see Key 3–2, note 83).

138. Einstein, *Mozart*, 84–85. In this regard, Einstein posited a loose connection between Mozart’s predilection for both esotericism and nonsense and the fact that Mozart and Freystädler were Masonic brothers.

139. Novalis, “Monologue,” 214.

140. Mozart’s metrical strategy momentarily gives the parallax impression that the movement has adopted a 6/8 time signature (as happens at the corresponding juncture in K. 491) while simultaneously remaining in 2/4.

141. Berger, *Bach’s Cycle, Mozart’s Arrow*, 191.

142. On *grammelot*, a language in which “onomatopoeia becomes the fulcrum of vocal expression,” see Bottini, “You Must Have Heard of Harlequin . . .,” 59.

143. As Barth put it, Mozart’s music is less concerned with the pursuit of equilibrium than with “a glorious upsetting of the balance, a *turning* through which light rises and the shadows fall.” Barth, *Wolfgang Amadeus Mozart*, 55.

144. Quoted and translated in Sutcliffe, “The Shapes of Sociability in the Instrumental Music of the Later Eighteenth Century,” 10.

145. In “hear[ing] Mozart at play,” Barth also heard “those boundaries which he imposed upon himself because it was precisely this discipline that gave him joy.” Barth, *Wolfgang Amadeus Mozart*, 16.

146. On the contributions of Sulzer and Koch, see Keefe, *Mozart’s Piano Concertos*, 9–23. See also Tovey, *The Classical Concerto*; Rosen, *The Classical Style*, 185–263; Kerman, *Concerto Conversations*; McClary, “A Musical Dialectic from the Enlightenment”; Keefe, “Theories of the Concerto from the Eighteenth Century to the Present Day”; DeNora, “The Concerto and Society”; Allanbrook, “Comic Issues in Mozart’s Piano Concertos”; and Currie, *Music and the Politics of Negation*, 1–39.

147. Rumph’s approach constitutes a notable exception to this rule: rather than approaching Mozart’s K. 450 as “a drama between individuated actors,” he perceives the concerto to enact “the process by which musical subjects take shape, working out their identity within the labile play of signs.” Rumph, *Mozart and Enlightenment Semiotics*, 136–37; see also Key 3–5, note 267.

148. See, for instance, Keefe, *Mozart’s Piano Concertos*, 178–85; and Currie, *Music and the Politics of Negation*, 35–37.

149. Allanbrook, *The Secular Commedia*, 145; Currie, *Music and the Politics of Negation*, 14.

150. Allanbrook, “Comic Issues in Mozart’s Piano Concertos,” 82, where the term is applied to the finale of K. 449.

151. On the musical and social range of the “learned style” as both topic and technique, see Chapin, “Learned Style and Learned Styles.”

152. Klorman, *Mozart’s Music of Friends*, 123; see also Sutcliffe, “The Shapes of Sociability in the Instrumental Music of the Later Eighteenth Century.”

153. Jones, “Troping as a Sign of Reciprocity in Mozart’s Piano Concertos.”

154. See Key 1–1, note 103–9.

4-4 MOZART AND MARIO PLAY THE FIELD

155. Pesic, “The Child and the Daemon,” 100–104; see also Byros, “Trazom’s Wit”; and Irving, *Understanding Mozart’s Piano Sonatas*.

156. Pesic, “The Child and the Daemon,” 104 and 98. For a near-contemporary account of the children’s games invoked by Pesic, see Tardieu-Denesle, *Les jeux innocents de société*.

157. See Key 3–3, note 154. Mozart also played notational games with the clarinetist Anton Paul Stadler: see Tenschert, “Fragment eines Klarinetten-Quintets von W.A. Mozart.”

158. Pesic, “The Child and the Daemon,” 102.

159. For Müller’s formulation of this point, see Key 3–2, note 127.

160. Staier, booklet accompanying *Mozart: Piano Concertos nos. 18 & D, 3*.

161. The autograph reveals this precise sequence of events to have been an afterthought: having initially cast the oboe and bassoon in framing roles, Mozart rescored the passage in order for the keyboardist’s hands to bookend canonic proceedings, both framing and enacting the contrapuntal mechanics underpinning the passage. On the agency of hands at the keyboard in Mozart’s music, see Klorman, *Mozart’s Music of Friends*, 144–55.

162. I am grateful to Peter Shultz for sharing his musical insights into *Super Mario Bros*. On Miyamoto’s credentials as a designer, see deWinter, *Shigeru Miyamoto*: on World 1–1

of *Super Mario Bros.* as a paragon of game design, see *ibid.*, 36–41; and Anthropy, “Level Design Lesson.”

163. See Key 5–5, *note 186*

164. On how the ludic and mimetic aspects of digital role-playing games can inform both musical and theatrical performance, see Cook, *Beyond the Score*, 258–65.

165. See Key 3–2, note 145. As Allanbrook observed, “the efforts of the blockers . . . assure the final celebration” (*The Secular Commedia*, 36): in Ivanovitch’s analogous terms, Mozart’s keyboard concertos present “constraints and conventions [that] must be treated as opportunities or possibilities, special limitations against which Mozart can press.” Ivanovitch, “Showing Off,” 215.

166. Quoted in Ryckert, “Mario’s Creators Answer Burning Questions about the Series.” *Super Mario Bros.* 3 (1988) is conspicuously mounted as a theatrical production, complete with costumes, curtains, and elaborate stage machinery. Theatricality is also foregrounded in *Paper Mario RPG [Paper Mario: The Thousand-Year Door]* (2004), in which battles take place on a stage before a rowdy diegetic audience.

167. Mozart to Leopold Mozart, December 28, 1782, in *Briefe*, 3:245–46; translation in Spaethling, *Mozart’s Letters*, 336. This much-discussed passage has been glossed most recently by Allanbrook, *The Secular Commedia*, 79–80; and Ivanovitch, “Showing Off,” 216.

168. Miyamoto and Iwata, “Iwata Asks: *New Super Mario Bros. Wii*, Volume 1,” sections 9 and 8.

169. Just as Mozart adapted the difficulty level of K. 449 for Ployer (see Key 4–3, note 110), Miyamoto made allowances in the design of *New Super Mario Bros. Wii* that enable players to progress through the game regardless of their skill: see Miyamoto and Iwata, “Iwata Asks: *New Super Mario Bros. Wii*, Volume 1,” section 5. It might also be noted that the original *Mario Bros.* arcade game, designed by Miyamoto in 1983, greets players with the opening measures of Mozart’s *Eine kleine Nachtmusik*, K. 525 (1787). The same work is featured in *Wii Music* (2008, discussed in Key 5–1), the tutorial of which also nods to Mozart by teaching players to improvise variations on “Twinkle, Twinkle, Little Star” after the fashion of Mozart’s variations on “Ah! vous dirai-je, maman,” K. 265/300e (ca. 1781–82).

170. Schroeder undertakes such a maneuver by comparing Mozart’s keyboard concertos to Akira Kurosawa’s film *Rashomon* (1950) and Tom Tykwer’s *Run Lola Run* (1998) in *Experiencing Mozart*, 78–82. While concertos and films might be comparable from a spectator’s standpoint, however, digital games engage players more directly by drawing them into the action. On distinctions between and commonalities shared by “old” and “new” media, see Dovey and Kennedy, *Game Cultures*, 3; and Chun, Watkins Fisher, and Keenan, *New Media, Old Media*.

171. On Kondō’s approach to scoring *Super Mario Bros.*, see Key 5–1, notes 69–73; on the (a)synchrony of music and action in digital games, see Donnelly, “Lawn of the Dead.”

172. Berger notes the “excitement of improvisatory acrobatics” attending the cadenzas of Mozart’s concertos in performance (*Bach’s Cycle, Mozart’s Arrow*, 185): see also Key 4–3, notes 121–22.

173. For Alan Liu’s concept of the reverse skeuomorph, see Key 1–2, note 160. Both the ingenious figuration of Mozart’s concertos and the fluid grace with which Mario can be prompted to soar through the Mushroom Kingdom (on which see Thompson, “But Our Princess Is in Another Castle”) endorse Pestic’s claim that “the sense of flying is necessary to the simplest gestures of the musical game; without enjoyment of the simplest moves, the whole remains a mechanical tour de force.” Pestic, “The Child and the Daemon,” 102.

4–5 BEETHOVEN'S RECURSIVE FEEDBACK LOOPS

174. Hoffmann, translated by Clarke, “Review of Beethoven’s Fifth Symphony”: Hoffmann proceeded to include the essay among his *Kreiseriana*, where it appeared as “Beethovens Instrumental-Musik.” Bonds believes it “scarcely an exaggeration to call E.T.A. Hoffmann’s review of Beethoven’s Fifth the most influential piece of music criticism ever written” (*Music as Thought*, 6). On the relation of Hoffmann’s review to hermeneutics in literary and philosophical contexts, see Chantler, *E.T.A. Hoffmann’s Musical Aesthetics*, 51–77.

175. Hoffmann, “Review of Beethoven’s Fifth Symphony,” 238 and 251.

176. *Ibid.*, 237.

177. See Kittler, *Discourse Networks, 1800/Ø00*, 77–112. As Keith Chapin (“Lost in Quotation”) and Matthew Riley (“E.T.A. Hoffmann Beyond the ‘Paradigm Shift’”) have pointed out, the scale and diversity of Hoffmann’s literary output and his mercurial rhetorical strategies cannot be reduced to a single consistent aesthetic and critical outlook.

178. See Goehr, *The Imaginary Museum of Musical Works*. While the broad outlines of this process have hardened into received wisdom, if not cliché, Bonds provides a fine-grained account of its origins and early development that complicates the narrative by tracing in detail its philosophical, aesthetic, and nationalistic ramifications (“Idealism and the Aesthetics of Instrumental Music at the Turn of the Nineteenth Century”).

179. See Key 3–1, note 61.

180. Cambini (attrib.), “Ausführung der Instrumentalquartetten.”

181. Quoted and translated in Klorman, *Mozart’s Music of Friends*, 81–82. Klorman points out that the attribution to Cambini is questionable: as translator, editor, ghostwriter, or some combination of the three, it seems likely that Rochlitz was at least partly responsible for the essay in its published form (*ibid.*, 84n37).

182. Esterhammer, *Romanticism and Improvisation*, 68; see also Caesar, “Poetic Improvisation and the Challenge of Transcription,” 174–83.

183. It is “not the poem which we have *read*, but that to which we *return*, with the greatest pleasure, [that] possesses the genuine power, and claims the name of *essential poetry*.” Coleridge, *Biographia Literaria*, 1:23.

184. *Ibid.*, 2:45–46.

185. Quoted and translated in Esterhammer, *Romanticism and Improvisation*, 8–9.

186. See Esterhammer, “Coleridge’s ‘The Improvisatore.’” The piece’s title reflects the ubiquity of Italian *improvvisatori* and *improvvisatrici*, whose prowess at extemporizing poetry in public had spread throughout Europe: see Esterhammer, *Romanticism and Improvisation*, 139–46. On operative manifestations of such praxis, see Esse, “Encountering the *Improvvisatrice* in Italian Opera.”

187. As Helga Slessarev points out, Hoffmann’s tale draws on depictions of the Roman carnival by Goethe and Schiller: the latter described “the gay attractive life of the Corso in Rome” as the only contemporary means by which the *Spieltrieb* could be satisfied (quoted and translated in “E.T.A. Hoffmann’s *Prinzessin Brambilla*,” 149). See also Esterhammer, *Romanticism and Improvisation*, 139–46.

188. “The audible sounds of nature, such as the rustling of wind or the rushing of a spring, are heard by the musician first as individual chords, then as melodies with harmonic accompaniment. With recognition the inner will is born. . . . The more vivid, the more pervasive the recognition is, the more does the musician become a composer; and the ability to hold on to

those intuitions as if with a special spiritual power and to preserve them in writing—that is the art of composition.” Hoffmann, “Johannes Kreisler’s Certificate of Apprenticeship,” 192.

189. See Whitmore, *Unpremeditated Art*, 12 and 181; and Kramer, *Unfinished Music*, 229–30. On the Romantic paradoxes thrown up by the notation (and subsequent performance) of “improvisation,” see Adorno, *Towards a Theory of Musical Reproduction*, 87.

190. See Kittler, *Discourse Networks, 1800/Ø00*, 3–173.

191. See Szás, “Figured Bass in Beethoven’s ‘Emperor’ Concerto.” As Caporaletti points out, however, the notion that Beethoven’s figured-bass notation implies “improvisatory” characteristics is itself a vestige of nineteenth-century aesthetics (“‘Ghost Notes,’” 359).

192. Quoted and translated in Plantinga, *Beethoven’s Concertos*, 130 and 127.

193. On the gauntlets picked up and thrown down by Beethoven’s cadenzas for Mozart’s K. 466, see Kramer, *Unfinished Music*, 211–2.

194. *Ibid.*, 200.

195. *Ibid.*, 199 and 201.

196. See Key 1–0, note 48. On Nägeli’s criteria, see Maurer Zenck, “‘Mannichfaltige Abweichungen von der gewöhnlichen Sonaten-Form,’” 53–55.

197. Quoted and translated in Maurer Zenck, “‘Mannichfaltige Abweichungen von der gewöhnlichen Sonaten-Form,’” 58; see also Richards, *The Free Fantasia and the Musical Picturesque*, 134–36.

198. Quoted and translated in Wheelock, *Haydn’s Ingenious Jesting with Art*, 196.

199. Quoted and translated in Cooper, commentary on *Beethoven: The 35 Piano Sonatas*, 2:41.

200. *Ibid.*; Taub, *Playing the Beethoven Piano Sonatas*, 165; Rosen, *Beethoven’s Piano Sonatas*, 173. Ludwig Finscher contrasted the “intense introversion” of the first theme with the “playfully extraverted manner” of the second (“Beethoven’s Klaviersonate opus 31, 3,” 391), while Jones frames the entire movement as a “lyrical minuet” (*Beethoven*, 116).

201. On the application of the “word ladder,” a game invented by Lewis Carroll, to music, see Allanbrook, “Two Threads through the Labyrinth,” 145–46.

202. Even Beethoven’s enharmonic spelling of the G flat4s in mm. 4–5 contributes to the confusion, as Tovey noted (*A Companion to Beethoven’s Pianoforte Sonatas*, 137). As heard in Audio 16, Malcolm Bilson performs the “shimmy” in m. 7 as the “Emperor”-like tattoo that appears in Clementi’s 1804 edition: see Cooper, commentary on *Beethoven: The 35 Piano Sonatas*, 2:41.

203. In this regard, the opening of the sonata echoes that of Beethoven’s early Piano Quartet in E flat, WoO 36 (1785), especially mm. 6–8. On Beethoven’s exposure to the *partimento* tradition, see Sanguinetti, *The Art of Partimento*, 7–8.

204. Riemann registered the jarring effect of the “grotesk hinab plumpsenden” octaves at this juncture (*L. van Beethoven’s sämtliche Klavier-Solosonaten*, 2: 428); Finscher considered the second theme to exhibit a “polonaisenhaften Melodietypus” (“Beethoven’s Klaviersonate opus 31, 3,” 391).

205. The discrepancies between these interpretations can be explained in syntactical terms that have epistemological ramifications. For Riemann, the chord forms one vertex of a subdominant-dominant pincer movement that homes in on the tonic in m. 7 (*L. van Beethoven’s sämtliche Klavier-Solosonaten*, 2:432), whereas from a Schenkerian perspective it is the chord’s supertonic root that proceeds to the tonic via the dominant, arcing around the circle of fifths

in the flatward direction. On the history of this ambiguous sonority and Rameau's attempt to rationalize it within the scope of his harmonic theory, see Christensen, "Thoroughbass as Music Theory," 28–33; and Holtmeier, "Heinichen, Rameau, and the Italian Thoroughbass Tradition," 22. On the *indugio*, see Gjerdingen, *Music in the Galant Style*, 273–83.

206. Tovey, *A Companion to Beethoven's Pianoforte Sonatas*, 137: the quotes around "Added Sixth" imply a reference to Rameau's *sixte ajoutée*.

207. *Ibid.*, 140.

208. I am grateful to Melina Esse for this observation. Cohn points out that this type of combinatory explanation can be traced back to Rameau's *Code pratique* (1760): he himself represents the sonata's opening chord as a parallelogram on the *Tonnetz* formed by two "R-related [relative-major/minor] triads straddling a major-third edge" (*Audacious Euphony*, 140 and 142).

209. In Cohn's terms, this passage enacts the R-transformation that maps out the parallelogram described in note 208 above by moving from an A-flat major to an F-minor sonority via an augmented triad, articulated at the midpoint of the twofold semitonal shift from E flat₃ to F₃ (*Audacious Euphony*, 61–65).

210. This line of inquiry can be extended by considering the opening chord as a sonority with origins, tonal contexts, syntactical functions, and affective associations that lie beyond any individual work or composer. Beyond his early Piano Quartet in E flat (see note 203 above), an immediate point of reference is provided by Beethoven's Septet in E flat, op. 20 (1799–1800), which shares its triple meter and persistent grace notes with op. 31, no. 3, as well as the chord in question: in both cases, it is rationalized by the tonic harmony that has set the piece in motion. Memories of Mozartian sonorities might also have informed Beethoven's handling of his material in op. 31, no. 3: the openings of both the String Quartet in E flat, K. 428 (1783), and the overture to *Die Zauberflöte* feature the same chord as a response to an opening gambit on the tonic that features prominent melodic motion from E flat to G. In turn, Schumann transposed and replayed Beethoven's gambit at the outset of his String Quartet in A, op. 41, no. 3 (1812).

211. The resultant *cadenza composta di salto* thus conforms to the criteria outlined by Diergarten: see Key 4–1, note 45.

212. On the *clausula perfecta*, see Gjerdingen, *Music in the Galant Style*, 172.

213. Similarly, Riemann understood the opening eight measures of the movement to foreshadow mm. 18–25 (*L. van Beethovens sämtliche Klavier-Solosonaten*, 2:427). On Marx's interpretation of Beethoven's op. 31 sonatas, which prefigure Rumph's identification of the purposive mechanisms of subject formation in Mozart's Keyboard Concerto in B flat, K. 450 (see Key 3–5, note 267; and Key 4–3, note 147), see Watkins, *Metaphors of Depth in German Musical Thought*, 72–79.

214. For Winthrop-Young's analogous formulation of recursivity in general, see Key 1–2, notes 161–62.

215. See Key 1–1, note 106. On the laughter, both triumphant and mocking, with which Beethoven brought his keyboard extemporizations to a close, see Czerny's anecdotes in Kerst and Krehbiel, *Beethoven*, 35; and Lockwood, "Beethoven, Florestan, and the Varieties of Heroism," 40.

216. I am grateful to Malcolm Bilson for his compelling demonstration and discussion of these issues.

217. In this light, it is telling that op. 31, no. 3, contains Beethoven's last formally self-identifying minuet.

218. Kramer, *Unfinished Music*, 183.

219. On the resonances of Fontenelle's exasperated outburst ("Sonate, que me veux-tu?"), see Jerold, "Fontenelle's Famous Question and Performance Standards of the Day"; Hoffmann, "Review of Beethoven's Fifth Symphony," 98.

220. See, for example, Dahlhaus, *Ludwig van Beethoven*, 167–80; and Burnham, "Reading between the Lines," 441.

221. Quoted and translated in Maurer Zenck, "Mannichfaltige Abweichungen von der gewöhnlichen Sonaten-Form," 55.

222. Riemann, *L. van Beethovens sämtliche Klavier-Solosonaten*, 2:426. Warming to his *galant* theme, Riemann proceeds to relate the finale of Beethoven's sonata to a symphony by Dittersdorf (2:460–61). Burnham offers a skeptical reading of Riemann's maneuver in "Reading between the Lines," 449–50.

223. Riemann, *L. van Beethovens sämtliche Klavier-Solosonaten*, 2:424–26.

224. Burnham, "Reading between the Lines." On Riemann's approach to phrasing in relation to the importance he accorded the keyboard as the primary interface via which historical masterpieces were to be heard and read, see Scherer, *Klaver-Spiele*, 209–23.

225. Riemann, *L. van Beethovens sämtliche Klavier-Solosonaten*, 2:427; on Riemann's penchant for hearing the inaudible, see Key 1–0, note 7.

226. In Robert S. Hatten's terms, Riemann's "sigh" might be understood as a "strategic token" of an eighteenth-century rhetorical category; as Hatten observes in the context of the finale of Beethoven's earlier Sonata in E flat, op. 7 (1796), such gestures can be saturated with a Romantic longing that invests them with hermeneutical currency (*Interpreting Musical Gestures, Topics, and Tropes*, 133 and 141–45).

227. Kittler, *Discourse Networks, 1800/1900*, 3.

228. To illustrate this linguistic double bind, Kittler quotes Schiller: "Warum kann der lebendige Geist dem Geist nicht erscheinen? *Spricht* der Seele, so spricht, ach! schon die Seele nicht mehr." *Ibid.*, 3; see also Riou, "Music and Non-Verbal Reason in E.T.A. Hoffmann," 46–47.

229. Busoni, *Sketch of a New Esthetic of Music*, 16; see also Watkins, "The Floral Poetics of Schumann's *Blumenstück*."

230. Beethoven to Therese Malfatti, May, 1810, quoted and translated in Solomon, *Late Beethoven*, 43.

231. Prod'homme, "Un lied et une sonate de Beethoven": Burnham also notes the opening motive's resemblance to a birdcall ("Reading between the Lines," 449), while Ruth Halle Rowen suggests that the opening of the "Moonlight" Sonata, op. 27, no. 2, might also channel the quail's call ("Beethoven's Parody of Nature," 54).

232. Quoted and translated in Rowen, "Beethoven's Parody of Nature," 46.

233. On "Der Wachtelschlag," see *ibid.*, 54; and Wyn Jones, *Beethoven*, 23–24. Watkins describes how Heine's and Schumann's evocation of *Blumensprache* ("flower-talk") in *Dichterliebe*, op. 48, negotiates between sound and language ("The Floral Poetics of Schumann's *Blumenstück*," 31–32); Felix Mendelssohn's setting of Heine's "Auf Flügeln des Gesanges," op. 34, no. 2, also features flowers who await, giggle, tease, and whisper.

234. On the "Heiligenstadt Testament," see Lockwood, *Beethoven*, 15–23.

235. Wyn Jones, *Beethoven*, 23.

236. As Rowen observes, the quail whistle had been deployed as a hunting decoy as far back as the fourteenth century (“Beethoven’s Parody of Nature,” 53).

237. Cited in Prod’homme, “Un lied et une sonate de Beethoven,” 37.

238. On Kircher’s treatment of birdsong, which can be traced back to Pliny the Elder’s *Natural History*, see *ibid.*, 50–52; and Head, “Birdsong and the Origins of Music,” 12–B.

239. On the ideological and technological means by which distinctions were made relating to the meaning and affect of sounds produced by humans, birds, and machines, see Siegert, *Cultural Techniques*, 53–60; Head, “Birdsong and the Origins of Music,” 16–21; and Abbate, *In Search of Opera*, 73–77.

240. Rowen, “Beethoven’s Parody of Nature,” 49.

241. See Kurth, *Romantische Harmonik und ihre Krise in Wagners “Tristan,”* 72–73.

242. Burnham, “Reading between the Lines,” 453 (referring to m. 64f.); Riemann, quoted and translated in *ibid.*, 459. On the cultural forces behind the imperative to locate such Riemannian imperatives in Beethoven’s op. 31 sonatas and beyond, see Watkins, *Metaphors of Depth in German Musical Thought*, 79–85.

243. See Key 5–0, note 28.

244. See notes 205–9 above. The same ludic obstacle, compounded by disorienting metrical displacements, presents itself in mm. 5–12 of the Menuetto from Haydn’s String Quartet in F, op. 77, no. 2.

245. For Friedrich Schlegel, “[a] fragment should be like a little work of art, complete in itself and separated from the rest of the universe like a hedgehog.” Schlegel, *Athenaeumsfragment* 206, translated in Rosen, *The Romantic Generation*, 48. For an application of Schlegel’s poetics to Beethoven’s music, see Longyear, “Beethoven and Romantic Irony.”

246. Hoffmann, “Review of Beethoven’s Fifth Symphony,” 251; see also Bent, “Plato—Beethoven,” 121–24. In this sense, Beethoven’s bagatelles echo the “Spiel mit dem Spiele” that Tieck observed in his own literary comedies (quoted in Longyear, “Beethoven and Romantic Irony,” 651).

247. On Beethoven’s deafness from various cultural, historical, technological, and medical perspectives, see Straus, *Extraordinary Measures*, 45–62; Knittel, “Wagner, Deafness, and the Reception of Beethoven’s Late Style”; Ealy, “Of Ear Trumpets and a Resonance Plate”; and Karmody and Bachor, “The Deafness of Ludwig van Beethoven.”

248. See note 206 above.

249. Beethoven to Franz Wegeler, June 29, 1801, quoted and translated in Ealy, “Of Ear Trumpets and a Resonance Plate,” 263; Beethoven to Carl and Johann Beethoven, October 6, 1802 (“Heiligenstadt Testament”), quoted and translated in Weiss, *Letters of Composers through Six Centuries*, 167.

250. Such means included ear trumpets made by Maelzel, which Beethoven called “hearing machines”: see Ealy, “Of Ear Trumpets and a Resonance Plate,” 266–67; and Scherer, *Klavier-Spiele*, 156–57. As Scherer notes, an “Elektro-Vibrations-Maschine” that promised to cure deafness caught Beethoven’s attention in 1809 (*ibid.*, 157). That notwithstanding, we can infer that Beethoven’s primary approach to the communicative challenges posed by his deafness relied on the time-tested techniques and technologies of reading and writing messages on paper.

251. Kittler, “England 1975,” 473, quoted and translated in Winthrop-Young, *Kittler and the Media*, 54.

252. On Stein's device, see Skowronek, "A Brit in Vienna," 59–60; on Graf's "resonance plate," which seems to have been less efficacious, see Ealy, "Of Ear Trumpets and a Resonance Plate," 270–73.

253. Quoted and translated in Solomon, *Mozart*, 339.

254. It is noteworthy—if perhaps self-evident—that paper has proved to be an indispensable medium across the spectrum of Mozart studies, from Alan Tyson's philological materialism (*Mozart*) to Chua's poststructuralist criticism ("Myth").

255. Hoffmann romanticized and pathologized Mozart's feat in his novella *Ritter Gluck*: as John T. Hamilton notes, when the eponymous composer takes to the keyboard to play his "true music," he reads from a blank sheet of manuscript paper (*Music, Madness, and the Unworking of Language*, 190–91; see also Key 2–3, note 176).

256. See Key 5–5, note 187

257. The notion is attributable to Artur Schnabel, who was "attracted only to music which I consider to be better than it can be performed" (*My Life and Music*, 121), but can be grounded in the aesthetic and epistemological implications of Beethoven's famous—if apocryphal—scorn for Ignaz Schuppanzigh's "wretched fiddle," as noted by Carl Dahlhaus (*Nineteenth-Century Music*, 10).

258. On scores as indices of personal, familial, and social memory, see Davies, "Julia's Gift"

259. Such accounts are often indebted to Benjamin's "The Work of Art in the Age of Mechanical Reproduction": for historical, technological, aesthetic, and sociological approaches that depart from Benjaminian orthodoxy in different ways, see Kittler, *Gramophone, Film, Typewriter*; Sterne, *The Audible Past*; Katz, *Capturing Sound*; Eisenberg, *The Recording Angel*; Ashby, *Absolute Music, Mechanical Reproduction*; and Cook, *Beyond the Score*, 337–413.

KEY 5 PLAY AGAIN?

1. On the virtuosity and multiplicity of Liszt's transcriptions, see Kregor, *Liszt as Transcriber*; on the threat they posed to the ontological grounding of the musical work, see Raykoff, "Transcription, Transgression, and the (Pro)creative Urge."

2. See Kregor, *Liszt as Transcriber*, 149–85; and Rosen's account of Liszt's *Réminiscences de Don Juan* (*The Romantic Generation*, 528–41).

3. On Clara's performances from memory, see Reich, *Clara Schumann*, 271–72; for a broader perspective on the phenomenon and the ambivalence with which it was greeted by critics, see Hamilton, *After the Golden Age*, 73–81.

4. On Liszt's fidelity, see Kregor, *Liszt as Transcriber*, 131–43. On Schumann's improvisations, see Goertzen, "Setting the Stage"; and Goertzen, "Clara Wieck Schumann's Improvisations and Her 'Mosaics' of Small Forms."

5. See Key 2–3, note 192.

6. See Key 4–1, note 27.

7. See Key 2–2, note 116.

8. See Key 4–1, note 18.

9. See Key 4–1, notes 24–25.

10. For a contemporaneous complaint that flags up the tautological risks attending such specificity, see Rowland, "Piano Notation in Chopin and Liszt's Paris," 1 B–14.

11. See Key 1-5, notes 249-50; and Key 4-5, notes 224-26.
12. In addition to its prosecution throughout *Gramophone, Film, Typewriter*, this central thesis is distilled in Kittler's *Optical Media*, 29-35.
13. See Key 4-1, note 25; Key 1-2, note 131; and Key 2-2, notes 1B-15.
14. See Key 2-3, notes 193-94.
15. Edison, "The Phonograph and Its Future," 533. In a similar vein, the Victor Talking Machine Company promised to revive listener's cherished memories of the tenor Francesco Tamagno "by bringing the voice of this singer back from the grave" (quoted in Leppert, *Aesthetic Technologies of Modernity*, 102).
16. Adorno, "The Form of the Phonograph Record," 279. Adorno's suggestion has been taken up by Lisa Gitelman (*Always Already New* and *Scripts, Grooves, and Writing Machines*); Jonathan Sterne (*The Audible Past*); Scherer ("Klaviaturen, Visible Speech und Phonographie"); and Feaster ("Speech Acoustics and the Keyboard Telephone"), among many others.
17. Feaster provides a corrective to such teleological historicism in "Speech Acoustics and the Keyboard Telephone": see also Suisman, "Sound, Knowledge, and the 'Immanence of Human Failure.'" On fidelity and morbidity, see Rothenbuhler and Peters, "Defining Phonography," 245; Leppert, *Aesthetic Technologies of Modernity*, 1B-29 and 133-34; and Stanyek and Piekut, "Deadness."
18. On the implications of such recreation, see Butler, *Playing with Something That Runs*, 1-11; and D'Errico, "Interface Aesthetics."
19. For discussion of the qualities of early-twentieth-century piano rolls in relation to contemporaneous phonographic recordings, see Philip, *Performing Music in the Age of Recording*, 30-34. For an overview of the more recent controversies arising from the digital remastering (or even "reperforming") of analog recordings, see Ashby, *Absolute Music, Mechanical Reproduction*, 123-6.
20. See Key 1-1, note 97; and Key 3-2, note 124.
21. "Vielleicht werden die Kinder selbst, sobald sie einmal merken, wieviel das Klavier ihnen sich zu vergegenwärtigen erlaubt, was ihnen anders fremd bleibt, des Gedudels müde und buchstabieren sich lieber Beethovenonaten zusammen." Adorno, *Dissonanzen*, 106.
22. "Dagegen möchten wir für alle Kinder die Freiheit erbitten, bisweilen auf dem Klavier nach ihrer Art herumzuspielen, zu suchen, selbst herumzutosen, soweit es ohne Beschädigung des Instruments angeht. Dieses Spiel wird meist unterdrückt, besonders wenn der Klavierunterricht begonnen hat; man sagt dem Kinde, es solle sich lieber nützlich beschäftigen mit Fingerübungen und aufgeschriebene Tonstücken. Aber woran soll sich der eigne Sinn, die noch unselbständige Tonphantasie halten, wenn man ihr dieses einzige und eben in dieser Zeit ganz unentbehrliche Hilfsmittel entzieht?" Marx, *Allgemeiner Musiklehre*, 326.
23. Kurtág, *Játékok*, 1:9. On *Játékok* in historical, political, and ludic contexts, see Beckles Willson, *Ligeti, Kurtág, and Hungarian Music during the Cold War*, 148-57; and Coelho, "Kurtág's *Játékok*." I am grateful to Xak Bjerken and David Friend for introducing me to various aspects of *Játékok*.
24. On *Jeux d'enfants*, see Key 1-1, note 107.
25. Scarlatti's Keyboard Sonata in B minor, K. 27, choreographs an analogous game of leapfrog for its solitary player, transforming the otherwise unremarkable repetitions of mm. 11-16 and 47-52 into a hand-crossing (and hair-raising) obstacle course. I am grateful to David Yearsley for showcasing his virtuosic realization of K. 27's ludomusical potential.

26. In this regard, “Saute-mouton” is akin to two of its stablemates that also represent bodies in motion: “Le volant” (“Battledore and shuttlecock”) and “Les bulles de savon” (“Soap bubbles”).

27. As were many of Kurtág’s *Játékok*, which the composer often performs with his wife Márta, Bizet’s *Jeux d’enfants* was written with specific individuals in mind: the conspicuously feminine indications of “prima” and “seconda” throughout the score reflect their dedication to “Mesdemoiselles Marguerite de Beaulieu et Fanny Gouin,” daughters of a cousin and a friend of Bizet’s wife Geneviève.

28. Abela, “Pinball Pianola.”

29. On the social and technological factors implicated in and emerging from this development, see Sterne, *MP3*; Gopinath, *The Ringtone Dialectic*; Butler, *Playing with Something That Runs*; and Gopinath and Stanyek, *The Oxford Handbook of Mobile Music Studies*. See also Key 5-5, *note 188*

5-1 NINTENDO’S BRAND OF LUDOMUSICALITY

30. In this regard, digital games might be set alongside Zen Buddhism and the history of its remediation between Japan and the West, on which see Yamada, *Shots in the Dark*. For further perspectives on issues of authenticity and reproduction in Japanese culture, see Cox, *The Culture of Copying in Japan*.

31. Examples of such rhetoric in Japan include the concepts of *nihonjinron* (theories and discourses on “Japaneseness,” which became widespread in the years following the Second World War) and, more recently, *Garapagosu-ka* (“Galápagos syndrome”), which refers to a specialized and geographically isolated evolutionary “branch” of a global commodity. I am deeply grateful to Aya Saiki not only for sharing this observation, but also for her substantial contributions to this Key via her research, critical insight, and translation of Japanese sources.

32. See, for instance, deWinter, “Japan”; and Tobin, *Pikachu’s Global Adventure*.

33. Tsuji, *Playfulness in Japanese Art*, 9–14.

34. Cox, “Is There a Japanese Way of Playing?,” 183.

35. Saitō, *Gēmunikusu to wa nani ka*, 204–7.

36. *Ibid.*, 204–7. On the playfulness, wit, and humor that characterize *ukiyo-e*, see Jenkins, *The Floating World Revisited*; on representations of musical activities in such prints, see Binns, “Looking and Listening.”

37. Quoted in Ono, “‘Gamenics’ and Its Potential,” 378.

38. On miniaturization in Japan, see Lee, *The Compact Culture*; and Yoshida, Tanaka, and Sesoko, *The Compact Culture*.

39. See Yoshida, Tanaka, and Sesoko, *The Compact Culture*, 26–31.

40. See Key 1-0, notes 20–25. In keeping with Lévi-Strauss’s observation of the chiasmic relation between play and ritual (see Key 1-0, note 17), the tea ceremony can be understood to enact a form of play that depends upon strict rules in order to create singular and unrepeatable experiences (summed up by the maxim *ichi-go ichi-e*, commonly attributed to the sixteenth-century tea master Sen no Rikyū).

41. Stein, *The World in Miniature*, 52.

42. The Nintendo designer Gunpei Yokoi was interested in digital gameplay that could exceed the frame of the television screen, as manifested by several accessories that he de-

signed for the Famicom: see Makino, *Gēmu no chichi, Yokoi Gunpei den*, 183–85. More than twenty years after the appearance of the Famicom, Miyamoto expressed a similar outlook: “I’ve always thought that games would eventually break free of the confines of a TV screen to fill an entire room.” Quoted in Hall, “Online Extra.”

43. Jakuchū’s *Birds, Animals, and Flowering Plants in Imaginary Scene* is a pair of six-panel folding screens comprising more than 86,000 pixel-like squares. (For comparison’s sake, the two screens of the Nintendo DS incorporate 98,304 pixels.) On Jakuchū, see Tsuji, *Playfulness in Japanese Art*, 63–74; on the multiple functions of the folding screen in Japanese culture, see Impey, *The Art of the Japanese Folding Screen*.

44. See Kitagawa, “Music Culture,” 264. I am grateful to Aya Saiki for this observation.

45. Nintendo’s handheld DS and 3DS systems respond to the player’s breath via their built-in microphone, while the 3DS also contains a gyroscope and accelerometer that recognize gestural input. On the Game Boy’s importance to circuit benders and chiptuners, see Tonelli, “The Chiptuning of the World”; Collins, *Playing with Sound*, 108–20; and Pasdzirny, “Geeks on Stage?”

46. See Moseley, “Playing Games with Music (and Vice Versa).”

47. The sophisticated use of musical instruments to perform actions within digital game-worlds can be traced back to Lucasfilm Games’ *Loom* (1990–92), a fantastical graphic adventure in which players must learn and deploy randomly generated sequences of notes that the protagonist “weaves” on his distaff.

48. On instrumentality, mechanization, and mediation in *Die Zauberflöte*, see Abbate, *In Search of Opera*, 55–106. Mozart’s music itself inspired ludic inventions, exemplified by a board game based on *Die Zauberflöte* produced in 1793 and illustrated in Bauer, *Mozart*, 250. A variant of Snakes and Ladders, the game features the iconographical repertoire of the opera—the characters, the serpent, the eponymous flute—as it enacts and regulates the ups and downs of players’ journeys toward the ultimate goal, the Temple of Wisdom. For a contemporary counterpart, which relates the opera’s plot in the course of subjecting Tamino to the trials of sliding-tile puzzles, see Lab Like’s *Magic Flute* (2015).

49. On the ludomusical mechanics of the Ocarina of Time, see Bruno, “Noteworthy.”

50. *The Legend of Zelda: Ocarina of Time* also allows players to compose an eight-note melody, which the game stores and recognizes as the “Scarecrow’s Song.”

51. On Fröbel’s *Fingerklavier*, see Key 2–3, note 151. A strong advocate of Fröbel’s concepts, Bradley formulated the standard colors still used today in the production of Fröbel’s *Spielgabe* (play-gifts) for young children, the first of which consists of six brightly colored balls of yarn.

52. Nintendo’s *Rhythm Heaven* series of digital games, which aim to improve players’ rhythm by presenting them with tasks of synchronization via ludicrous audiovisual montages, might be considered alongside *Wii Music*: see Kaneda, “*Rhythm Heaven*”; and Moseley and Saiki, “Nintendo’s Art of Musical Play,” 58–60. On *Wii Music*, see Jones and Thiuvathukal, *Codename Revolution*, 134–37; and deWinter, *Shigeru Miyamoto*, 69–72. As distinct from the single-player focus of *Rhythm Heaven*, *Wii Music*’s emphasis on multi-player musical performance can be placed in a Nintendian lineage that also includes *Dai-gasso! Band Brothers* for the DS (2004) and its sequels for both DS and 3DS (2008 and 2013, respectively).

53. Quoted in Terdiman, “Video Game Legend Miyamoto Talks *Wii Music*.”

54. Quoted in Miyamoto and Iwata, “Iwata Asks: *Wii Music*,” section 4. I am grateful to Jason DeSante for bringing this interview to my attention.

55. Quoted in McWhertor, “Miyamoto: *Wii Music* Is ‘More Interesting than a Video Game.’” In terms of the keyboard, *Wii Music*’s instrumentarium includes the toy piano alongside its full-sized counterpart and a “galactic” variant (not to mention the harpsichord).

56. Quoted in Miyamoto and Iwata, “Iwata Asks: *Wii Music*,” section 4. Iwata’s comparison was presumably aimed at conventional rhythm-action games such as *beatmania*, *Guitar Hero*, and *Rock Band*. In 2015, Harmonix Music Systems’ *Rock Band 4* introduced an analogous combinatorial improvisatory system to that featured in *C.P.U. Bach* and *Wii Music* for the performance of solos.

57. Quoted in Phillips, “Miyamoto: Nintendo’s Game Ownership Policy Should Operate ‘like a Toy Company.’” Nintendo’s long-standing president Hiroshi Yamauchi, who ran the company from 1949 until 2002, approvingly cited Caillois’s taxonomy (see Table 1) in terms of its relevance for digital games in general and *Space Invaders* in particular: see Gorges and Yamazaki, *The History of Nintendo, 1889–Ð80*, 189.

58. Agamben, *Infancy and History*, 80.

59. Sutton-Smith, *Toys as Culture*, 58; see also Susan Stewart, *On Longing*, 57–60.

60. Yokoi, *Monozukuri no inobēshon*, 44.

61. On *kareta gijutsu no suihei shikō*, see Yokoi, *Monozukuri no inobēshon*; and Yokoi and Makino, *Yokoi Gunpei gēmu-kan*.

62. Yokoi and Makino, *Yokoi Gunpei gēmu-kan Returns*, 199–200. Nintendo continued to espouse Yokoi’s outlook after his departure from the company in 1996 and his untimely death the subsequent year: in particular, the DS and Wii systems bear his hallmarks. See Inoue, *Nintendo Magic*, 122–45.

63. On the history of Nintendo’s entanglement with gambling, see deWinter, “Japan,” 321–22.

64. On the “modernity” of limited animation, see Lamarre, *The Anime Machine*, 184–206.

65. On the interwoven histories and aesthetics of *manga*, *anime*, and digital games, see deWinter, “Aesthetic Reproduction in Japanese Computer Culture.”

66. Iwai was inspired by a “hand-cranked antique music box” that used “paper cards, punched like the rolls on a player piano” (quoted in Morse, “Pre-Cinema Toys Inspire Multimedia Artist Toshio Iwai”). Iwai considers the fl pbook to mark the “starting point of the moving image,” while the music box represents a corresponding breakthrough in the transduction of image into sound, and vice versa: “For me, the fl pbook and the digital game are directly connected, bypassing the history of film and television. . . . I think the Game Boy restored the value of the fl pbook, which had been dormant for more than a century, by returning it to our hands in electronic form.” Iwai, *Iwai Toshio no shigoto to shūhen*, 70 and 64.

67. *Ibid.*, 64.

68. See Key 5-5, *note* 192.

69. See Diamante, “Kōji Kondō’s Interactive Musical Landscapes”: on the Game & Watch, see Key 1-4, *notes* 225–26.

70. On Kondō’s music for *Super Mario Bros.*, see Lerner, “Mario’s Dynamic Leaps,” 11–25; and Paul, “Droppin’ Science,” 71–73.

71. See Parish, “Mario Maestro Shares His Secrets.”

72. Quoted in Kohler, “Kōji Kondō Interview.”

73. According to Adam L. Kern, *kabuki* “routinely breaks the fourth wall, closing the gap between stage and audience for a variety of calculated reasons: playfulness; a bid for authority or authenticity; dramatic effect, and so on.” Kern, “Kabuki Plays on Page—and Comicbook Pictures on Stage—in Edo-Period Japan,” 182. The theatricality of *New Super Mario Bros.* can be traced back to *Super Mario Bros.* 3: see Key 4-4, note 166. Tellingly, the theater also serves as the master trope for Nintendo’s poetics of play as revealed by *WarioWare D.I.Y.* (2009–10), discussed in Key 5-2, which enables players to create games by producing and combining graphics, cel animation, sequenced music, and scripted artificial intelligence.

74. Phoenix, *Plastic Culture*, 9.

75. See Lerner, “Mario’s Dynamic Leaps,” 26.

5-2 ANALOGOUS DIGITALITIES

76. Kittler, *Gramophone, Film, Typewriter*; Siegert, *Passage des Digitalen*.

77. In *Ein Schattenspiel*, scored for piano and electronics, the pianist is chased by his or her own shadow, which occupies the cracks between the keys: after an initial twenty-four-second delay, every note played is played back 2.93 percent faster (and thus 50 cents higher), and the moment at which the recording catches up with the pianist’s live playing coincides with the end of the piece. I am grateful to Ryan MacEvoy McCullough for this information, and for bringing *Ein Schattenspiel* to my attention.

78. On how noise and error can afford opportunities for the creative and critical re-purposing of information and its mediation, see Krapp, *Noise Channels*; and Nunes, *Error*.

79. On the live orchestral performance of digital-game soundtracks, see Cheng, *Sound Play*, 173–75; and Moseley, “Music, Visual Culture, and Digital Games,” 382. On the ubiquity of chiptunes, see Tonelli, “The Chiptuning of the World,” 412–17.

80. See Key 1-4; and Key 5-5, note 190.

81. On these phenomena, see Key 1-4, notes 236–40; Key 2-2, notes 120 and 135–36; and Key 2-5.

82. See Key 1-4, note 216.

83. See Key 1-4, note 242; Key 2-0, note 4; Key 5-1, notes 49–50; and Heilmann, “Digitalität als Taktilität.”

84. Quoted in Gorges and Yamazaki, *The History of Nintendo, 1889–1980*, 146. On the one hand, the notion of grafting such a digital interface onto a toy-like drum foreshadows Namco’s *Taiko no Tatsujin*, a series of rhythm-action games that made its arcade debut in 2001. In 2003, Namco adapted *Taiko no Tatsujin* for Nintendo’s domestic audience by developing *Donkey Konga*, a rhythm-action game for the GameCube that was bundled with a pair of barrel-shaped bongos. As well as riffing on the iconology of the original *Donkey Kong* arcade game created by Miyamoto alongside Yokoi in 1981, *Donkey Konga* and its bongos could be interpreted as a punning tribute to the Ele-Conga.

85. The genesis of the Ele-Conga is briefly described in Yokoi and Makino, *Yokoi Gunpei gēmu-kan Returns*, 40–43.

86. See Key 1-4, notes 212–14.

87. See, for instance, the “music disk” designed by Claude-Félix Seytre in 1842, reproduced in Moseley, “Playing Games with Music (and Vice Versa),” 298.

88. Whether on cylinders or disks, the course of melographic plotting can trace either circles or spirals.

89. Kircher's organ can be placed in a long tradition of mechanical clocks and organs that animated doves, roosters, biblical figures, angels, devils, and skeletons, among other things: Riskin points out that the earliest documentation of such devices dates from the mid-fourteenth century ("Machines in the Garden," 23).

90. On the music for *Donkey Kong*, composed by Miyamoto and Yukio Kaneoka, see Lerner, "Mario's Dynamic Leaps," 2–11: the "hammer music" is transcribed in Example 1.5 (p. 7). See also note 84 above.

91. Methods of producing, performing, recording, and recreating music have been supplied by many of Nintendo's games and products, including *Mario Paint* (1992), *The Legend of Zelda: Ocarina of Time* (on which see Key 5–1, notes 49–50), and the inbuilt sound applications for Nintendo's DSi and 3DS handheld systems.

92. Despite its allusions to Pythagoras and Virgil, Kircher's image makes explicit his Christian allegiance via the musical ubiquity of the number three as well as the Latin text directly above the keyboard: see also Key 2–5, note 231.

93. For an iconophobic analysis of the proselytizing motives behind Kircher's media technologies, see Kittler, *Optical Media*, 76–81.

94. See Noble, *Forces of Production*, 147–52; Key 1–4, note 239; and note 83 above.

95. See Otis, *Networking*, 35; and Key 1–4, note 240.

96. The term is Alan Liu's: see Key 1–2, note 160. On Hollerith's machine and its successors, which transformed the tabulation of statistics, see Heide, *Punched-Card Systems and the Early Information Explosion, 1880–1945*. On Haass, see Patteson, *Instruments for New Music*, 19–21; on Nancarrow, see Key 3–4, note 205. In Zsanett Szirmay and Bálint Tárkány-Kovács's "soundweaving" project (2014), "the traditional cross-stitching pattern used in Hungarian folk embroidery [is] transformed into sound by a punch card comb music player." Szirmay and Tárkány-Kovács, "Soundweaving." The project thus explores the intersection between textility and musicality that constitutes media-archaeological common ground shared by Jacquard's loom and the piano roll, the digital game *Loom* (see Key 5–1, note 47), and the Nintendo Knitting Machine (1987), a peripheral for the Famicom that was prototyped but never commercially produced.

97. See Agamben, *Infancy and History*, 80.

98. See Krämer, "The Cultural Techniques of Time Axis Manipulation," 103–4.

99. See Lerner, "The Origins of Musical Style in Video Games, 1977–1983?"

100. See LeMieux, "From NES-4021 to moSMB3.wmv."

101. Rothenbuhler and Peters, "Defining Phonography," 246; see also Key 1–4, note 227.

102. See Levin, "'Tones from out of Nowhere,'" 44–47; Patteson, *Instruments for New Music*, 88–90; and Katz, *Groove Music*. Contemporary artists such as Abela (see Figure 80 and Key 5–0, note 28) have continued to wring new ludomusical forms from the materiality of phonographic media: see, for instance, Abela's *Vinyl Rally* (2009), in which remote-controlled cars race around a track constructed from records while styli attached to them transmit the sounds picked up en route.

103. Quoted and translated in Levin, "'Tones from out of Nowhere,'" 45; see also Patteson, *Instruments for New Music*, 89–90; and Key 2–2, note 129.

104. Rainer, "Promises of Music for the Eye," 47; see also Jutz, "Not Married," 76–81. At the hands of Walter Ruttmann, Ludwig Hirschfeld-Mack, Mary Ellen Bute, and others, the

convergence of the visible and the audible was explored via a range of artistic techniques and media technologies in the 1920s and 1930s.

105. On Pfenninger, see Levin, “‘Tones from out of Nowhere’”; and Patteson, *Instruments for New Music*, 109–B. At around the same time, analogous techniques and technologies were explored by Arseny Avraamov, Mikhail Tsekhanovsky, Boris Yankovsky, Nikolai Voinov, Yevgeny Sholpo, and Georgy Rimsky-Korsakov in the Soviet Union (see Smirnov, *Sound in Z*, 175–236); by Eric Allan Humphriss in London; and, most famously, by Oskar Fischinger in Berlin.

106. Levin, “‘Tones from out of Nowhere,’” 58.

107. *Ibid.*

108. Quoted in *ibid.* Moholy-Nagy took advantage of Pfenninger’s fulfillment of his alphabetical wishes to produce *Tönendes ABC*, a short film whose soundtrack doubled as its image track (described in *ibid.*, 63–64; and Patteson, *Instruments for New Music*, 1B).

109. Quoted and translated in Levin, “‘Tones from out of Nowhere,’” 54–55; Lerner, “The Origins of Musical Style in Video Games, 1977–1983.” Patteson explicitly relates the monophony of Pfenninger’s “childlike” short film *Pitsch und Patsch* (1932) to “the techniques of early video game music.” Patteson, *Instruments for New Music*, 111–12 and 195n97.

110. On the appearance in *Phoenix* of Beethoven’s Bagatelle in A minor, WoO 59 (better known as “Für Elise”), see Lerner, “The Origins of Musical Style in Video Games, 1977–1983”; on Pfenninger’s renditions of Handel and Offenbach, see Levin, “‘Tones from out of Nowhere,’” 60. Fischinger cast aspersions on his rival Pfenninger by describing his technique as a “system . . . developed commercially to form the musical accompaniment to puppet and cartoon films.” Quoted in *ibid.*, 76n59.

111. See Key 1–5, note 255.

112. See O’Malley, *The First Jesuits*, 76–77. For a nuanced account of the infrastructural conditions under which Japanese musical culture developed after the Edo period, see Wade, *Composing Japanese Musical Modernity*. On the problematic ascription of “influence” and its implication in the projection of Western temporal models on the world at large, see Moxey, *Visual Time*, 2–3.

1B. Azuma, *Otaku*. On Foucault’s concept of the *dispositif*, which has been variously translated as “apparatus,” “ensemble,” and “system of relations,” see Foucault et al., “Le jeu de Michel Foucault,” 63.

5-3 THE LUDOMUSICAL EMERGENCE OF TOSHIO IWAI

1A. Iwai, *Iwai Toshio no shigoto to shūhen*, 64. I am grateful to Aya Saiki for this information as well as that indexed in notes 1B, 116, and 118 below.

1B. *Ibid.*

116. See Tozuka, *Gēmu ongaku*, 136.

17. I refer to the concluding line of Oscar Wilde’s preface to *The Picture of Dorian Gray*: “All art is quite useless” (4).

118. Tozuka, *Gēmu ongaku*, 137; see also Stockburger, “Sound-Image Relations in Video and Computer Games,” 132–34.

1D. Alongside “B.G.M. Mode,” players can unlock “Music Maker” mode, which enables them to program their own soundtracks using a simple sequencer. *Otocky*’s “B.G.M. Mode” anticipates Arcangel’s *Super Mario Clouds* (2002), in which Arcangel modified a *Super Mario Bros.* cartridge to remove almost all of the game’s iconic (topo)graphical elements and to

strip out Kondō's soundtrack, leaving only white clouds that scroll silently, pointlessly, and endlessly across the Mushroom Kingdom's impossibly blue sky.

120. On parallels between *Würfelspiele* and the generativity of digital-game music, see Phillips, *A Composer's Guide to Game Music*, 186–88.

121. The phrase is Hillis's: see Key 1–4, note 217. “Horizontal resequencing” and “vertical layering” are introduced and illustrated in Phillips, *A Composer's Guide to Game Music*, 188–202. On the ludomusical affordances, both consonant and dissonant, that such sequencing and layering provide in two *Legend of Zelda* games, see Medina-Grey, “Meaningful Modular Combinations.”

122. The compositional technique of vertical layering shares common ground with the means by which the “boxes” of Burmeister and Diruta were assembled (see Key 3–1, note 30). As Phillips notes, the iMUSE system developed by LucasArts Entertainment in 1994 blends horizontal resequencing and vertical layering to sophisticated effect, relying on the fungibility and manipulability of MIDI data to guide and respond to game events in real time (*A Composer's Guide to Game Music*, 206–7; see also Collins, *Game Sound*, 51–57).

123. See Key 4–1, note 17.

124. See Wilson, *Information Arts*, 766–67. At the time of writing, the Tokyo performance could be viewed at [youtube.com/watch?v=detM789SPI0](https://www.youtube.com/watch?v=detM789SPI0).

125. In association with Yamaha, Iwai proceeded to develop the TENORI-ON (2007), a portable electronic instrument that operates along similar lines to the sequencer used at the Tokyo performance of *MPIXIPM*: see Nishibori and Iwai, “TENORI-ON.” The principle of sonically representing the “moves” of Iwai and Sakamoto is similar to that guiding Cage and Duchamp's *Reunion* (see Key 1–1, note 82); the technological means, ludic regulations, and aesthetic ends of the two games were nonetheless quite distinct.

126. This component of the performance was based on Iwai's “Piano—as image media” (1995), first displayed at the Zentrum für Kunst und Medientechnologie, Karlsruhe. The media-genealogical lineage of this instrument can be traced back to Louis-Bertrand Castel's *clavecin oculaire*, on which see Hankins and Silverman, *Instruments and the Imagination*, 72–85.

127. On the phenomenological, social, cultural, and political ramifications of such looping as a constitutive technology of electronic dance music, see Butler, *Playing with Something That Runs*, 173–228; on its genealogy as modernist technique, see Albright, *Untwisting the Serpent*, 185–97 and 216–43.

128. Burns, “Inside *Electroplankton*”; Kayali, “Playing Music,” 66. See also Pichlmair, “*Electroplankton* Revisited”; Stockburger, “Sound-Image Relations in Video and Computer Games,” 139; and Dolphin, “Defining Sound Toys.”

129. In *Electroplankton*, the influence of *Music Insects* is on display in “Tracy,” while *Composition on the Table* appears as “Luminaria.”

130. Yokoi was the executive producer of *Sound Fantasy*, initially developed as *Sound Factory*. After its cancellation, the software was reworked for the PC by Maxis and published as *SimTunes* (1996), in which the influence of *Music Insects* is also tangible (see note 129 above).

131. See Key 5–5, note 191.

132. Although *Sound Fantasy* was canceled, Iwai was struck by Yokoi's receptiveness to the idea of a “play with sounds” rather than normative gameplay or composition: “I thought maybe my job is much closer to the work that Mr. Yokoi had been doing than to art.” Iwai, *Iwai Toshio no shigoto to shūhen*, 67.

133. Quoted in Iwai's online profile as winner of the Multimedia Content Association of Japan's Multimedia Grand Prix in 1997: the profile is no longer accessible.

5-4 HIGH SCORES: *NODAME CANTABILE*

134. In this sense, *Nodame Cantabile* is typical of the interwoven (re)mediation of cultural tropes and intellectual property described by deWinter ("Aesthetic Reproduction in Japanese Computer Culture," 120-24).

135. See Key 4-2, notes 82 and 85. I am grateful to Aya Saiki for alerting me to the presence of Mozart's Sonata for Two Keyboards in *Nodame Cantabile*.

136. As noted in Key 5-2, 5-3, and 5-4, several musical phenomena addressed in this Key have fallen under the umbrella of the Yamaha corporation, indicating its strong influence over Japanese musical culture, technology, and pedagogy.

137. Unlike Mozart, however, Chiaki assigns Nodame the nominally inferior role of second keyboard: see Key 4-2, note 98.

138. On the *duettino* from *Le nozze di Figaro*, see Allanbrook, *Rhythmic Gesture in Mozart*, 75-77; and Rumph, *Mozart and Enlightenment Semiotics*, 85-90 and 94-107.

139. Onscreen melodica aside, *Nodame Cantabile: Dream Orchestra* relies on the mechanics and iconography of *Taiko no Tatsujin* and *Donkey Konga* (see Key 5-2, note 84): all three games were developed by [Bandai] Namco.

140. On the dichotomy between "the mechanical and the expressive" within the institution of the conservatory, see Kingsbury, *Music, Talent, and Performance*, 136-42.

141. Miller, *Playing Along*; Kaneda, "Rhythm Heaven."

142. Kirkpatrick, *Aesthetic Theory and the Video Game*, 41. The phrase "willing suspension of disbelief" was coined by Coleridge (*Biographia Literaria*, 2:6).

143. See Key 2-1, note 49; and Moseley, "Playing Games with Music (and Vice Versa), 300-305.

144. Brown, "Portrait of the Artist as a Young Geek"; Radosh, "While My Guitar Gently Beeps."

145. These oppositions are at once observed and reproduced in Benjamin's "The Work of Art in the Age of Mechanical Reproduction." As Antoine Hennion and Bruno Latour point out in their critique of Benjamin's essay, before the interests of the record industry dictated otherwise, "music was written to be played rather than recorded, and composers copied, transcribed, repeated, corrected, and adapted scores in a continuous web of themes and variations." Hennion and Latour, "How to Make Mistakes on So Many Things at Once," 95.

146. See, for instance, Sprenger, *Medien des Immediaten*; Rothenbuhler and Peters, "Defining Phonography"; Tresch, *The Romantic Machine*; and Taruskin, *Text and Act*.

147. See Key 5-2; and Key 4-1, notes 26-28.

148. See Key 5-5, note 189

149. See Key 1-4, note 227.

150. See Key 1-4, note 212.

151. Anonymous, "Recording the Soul of Piano Playing," 422-23. On the paradoxes of the digitally articulable soul, see Key 2-2, notes 112-5; Key 2-3, notes 186-88; and Key 3-4, notes 220-22.

152. On the configuration of memory in such terms, see Luhmann, *Introduction to Systems Theory*, 71–72: see also Key 2–1, note 69.

153. Kondō's "invincibility" music from *Super Mario Bros.* is featured in *Electroplankton's* "Beatnes."

154. The chords in mm. 87–88, 1–3, and 4 of the first movement of op. 31, no. 3, map onto the last three sonorities of Example 3 in reverse order. Torii's diminished-seventh staircase also bears direct comparison to an ascent based on the same pitch classes in Mozart's Modulating Prelude from C to B flat (discussed in Key 4–2), as can be heard at the beginning of Audio 8.

155. In 2008, the Nico Nico Douga user Terakuribo posted a ludomusical counterpart to Torii's medley. "Automatic Mario" (nicovideo.jp/watch/sm3462394) consists of a play-through of a custom-designed course for Nintendo's *Super Mario World* (1990–92), in which Mario's automated acrobatics trigger stingers and effects timed to coincide with the soundtrack. Independent of human guidance, he bounces from pillar to post through a dizzyingly complex course created using *Lunar Magic* (unofficial third-party course-editing software). Its soundtrack, "Kumikyoku Nico Nico Douga," is a medley compiled by Nico Nico Douga user Shimo that draws heavily on popular *anime* and digital-game music, including Kondō's original soundtrack for *Super Mario World*. Tellingly, courses centered on (semi-)automated musical recreation are among the most popular to be devised and shared using the tools officially built into *Super Mario Maker*, despite the fact that they are designed primarily to create traditional platform-based gameplay.

156. Benson, "Music to My Thumbs." In Benson's transcription, the stepwise motion of the melody from Beethoven's "Ode to Joy" lends itself to relatively straightforward platforming maneuvers, even when the descent from dominant to tonic is fraught with deadly piranha plants.

157. For yet another approach to the nexus of gameplay and notation, see Galloway, *RSG-SMB-TAB*. Closer in its radically literalistic spirit to the intermedial work of Arcangel, Galloway's text consists of an eight-hundred-page list, represented in quasi-musical tablature, that enumerates the Nintendo Entertainment System controller inputs with which Galloway completed *Super Mario Bros.*

158. Even when such tools have been withheld, as was the case with *Super Mario World* (see note 155 above), players have seized them via hacking and modding: for a brief historical overview of such practices, see Yang, "A People's History of the FPS."

159. See Khatchadourian, "World without End"; and Cunningham, "The Bizarre, Mind-Numbing, Mesmerizing Beauty of 'Twitch Plays Pokémon.'"

160. See Key 1–5, note 270.

161. Having emerged alongside Flusser from the ruins of Europe in the aftermath of the Second World War, Kurt Vonnegut drew on technologies associated with the keyboard to thematize the dehumanizing threat of mechanization. *Player Piano* (1952), his first novel, offers a bleak vision of a society riven by the inequality and misery wrought by mechanization and automation. In the closing pages, Professor Felix von Neumann surveys the wreckage with ludic equanimity: "He had been less interested in achieving a premeditated end than in seeing what would happen with given beginnings" (295). *Player Piano* can be read alongside William Gaddis's *Agapē Agapē* (2002), a sparsely punctuated novella that rails against mechanization and reserves particular vitriol for the player piano, its epistemological and industrial lineage (see Key 5–2, notes 81 and 96), and its dehumanizing effects.

162. See Key 1–3, note 174.

5-5 REPLAY: A CENTO

163. See *Prelude*, note 20.
164. See *Key 1-0*, note 52.
165. See *Key 1-2*, note 170.
166. See *Key 1-1*, note 123.
167. See *Key 1-3*, note 172.
168. See *Key 1-5*, note 247.
169. See *Key 1-4*, note 208.
170. See *Key 2-0*, note 2.
171. See *Key 2-1*, note 73.
172. See *Key 2-2*, note 141.
173. See *Key 2-3*, note 146.
174. See *Key 2-4*, note 199.
175. See *Key 2-5*, note 268.
176. See *Key 3-0*, note 15.
177. See *Key 3-1*, note 68.
178. See *Key 3-2*, note 70.
179. See *Key 3-4*, note 197.
180. See *Key 3-3*, note 139.
181. See *Key 3-5*, note 276.
182. See *Key 4-0*, note 7.
183. See *Key 4-1*, note 42.
184. See *Key 4-2*, note 84.
185. See *Key 4-3*, note 104.
186. See *Key 4-4*, note 163.
187. See *Key 4-5*, note 256.
188. See *Key 5-0*, note 29.
189. See *Key 5-4*, note 148.
190. See *Key 5-2*, note 80.
191. See *Key 5-3*, note 131.
192. See *Key 5-1*, note 68.
193. See *Key 5-5*, note 163.

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