Chapter 29

Glitched and Warped

Transformations of Rhythm in the Age of the Digital Audio Workstation

Anne Danielsen

Introduction

Digital music technology has brought about unforeseen possibilities for manipulating sound, and, as a consequence, entirely new forms of musical expression have emerged. This chapter will focus on the particular rhythmic feels that can now be produced through manual or automated techniques for cutting-up sound, warping samples, and manipulating the timing of rhythm tracks in digital audio workstations (DAWs). By rhythmic feel, I refer to the systematic microrhythmic design applied to a rhythmic pattern in performance or production, such as, for example, when playing a pattern with a swing or straight feel. These new rhythmic feels have made an unmistakable mark on popular music styles, such as glitch music, drum and bass, hip hop, neo-soul, and contemporary R&B from the turn of the millennium onward, and not only represent a challenge to previous forms but also create new opportunities for stretching the human imagination through presenting previously unheard sounds and sonic gestures to creators and listeners alike. A crucial aspect of this development is the manner in which the new technologies allow for combining agency and automation, understood as creative strategies, in new compelling ways.

In what follows, I will begin by reviewing two trends in the literature addressing these new rhythmic feels: one that positions them as a continuation of earlier machine-generated grooves; and another that positions them as an expansion of the grooviness of earlier groove-based music, such as funk, soul, and R&B, in unforeseen directions. Ultimately, I will reflect on the challenges faced by musicians and producers when it comes to anticipating the outcomes of processes involving the experimental use of new technology and, in turn, will acknowledge the potentially productive impact of the technologically unexpected on our sonic imaginations.

The Prehistory: "Organic" and "Machinic" Rhythms in the Popular Music Mainstream

According to Tim Armstrong (1998), two different views of the relationship between technology and the body exist within modernism. On the one extreme, there is technological utopia, represented by Freud's notion of technology as a positive prosthesis in which human capacities are extrapolated. In this view, "[t]echnology offers a re-formed body, more powerful and capable, producing in a range of modernist writers a fascination with organ-extension, organ-replacement, sensory-extension" (Armstrong 1998, 78). At the other extreme, we find writers adhering to the Marxist view of technology as an alienating means of industrial production. Here the technological advances underlying commodity capitalism result in a subordination of the human to the machine, promoting a nonhuman form of mechanical repetition and standardization. In the field of music, technology has generally taken on a role that is in accordance with the former view, namely as a positive extension of the human body. This pertains, for example, to traditional instruments such as pianos and

clarinets (see, for example, the discussion in Kvifte 1989) and to the increasing use of experimental recording and processing technologies. Some of the musical ideas that developed in rock in the late 1960s, for example, were not doable without such musical "prostheses." Similarly, within the field of electroacoustic music, various electronic and computerized technologies have been regarded as progressive and liberating tools for music creation. However, we also find tendencies of Marxist determinism that apply to music. This is prominent both in the discourse on various technologies' roles in promoting mass distribution of music and the Frankfurt school's critical discourse on popular music as a cultural response to the standardization and commodification typical of capitalist industrial production (Adorno 1990; Horkheimer and Adorno 2002).

In this chapter, I will focus on rhythmic popular music and use as my starting point the emergence of a discursive and performative tension that resonates with the Marxist view on technology just presented, in the sense that it situates human expression and machine-made musical creation as two opposing extremes. This tension developed as a response to the depreciation of disco and other repetitive rhythmic music as commercial and commodified "machine" music that emerged in the wake of the crossover success of black dance music in the popular music mainstream in the late 1970s.[1] The immense popularity of disco was probably crucial here; the style represented new tools (click track and the analog sequencer) and a new aesthetics (four-to-the-floor), and threatened the ideological and commercial position of white Anglo-American rock that, up to this point, had dominated the mainstream for several decades.[2] As a consequence, an increasing polarization between what might be called "organic" and "machinic" rhythms emerged.[3] On the one hand, artists played styles, such as rock, country, funk, and jazz, that were characterized by

rhythmic feels that derived from both deliberate and unintended variations that musicians add to their performances; on the other hand, there were artists who produced sequencer-based dance music with a futuristic machine aesthetic, as expressed in Kraftwerk's albums *Man-Machine* (1978) and *Computer World* (1981). These latter grooves, enabled by analog sequencers, were often perceived to be nonhuman and mechanistic, largely because of the absence of micro-level flexibility in the temporal placement of rhythmic events that were all forced into the grid provided by the sequencer. The absence of variation in sound in analog (and early digital) sequencer-based groove was probably also crucial to this dichotomy; the small shifts in *intensity* and *timbre* that are always present in performed music were absent in these early sequencer-based rhythms.[4] This division in rhythmic design within 1970s popular music is probably crucial to any subsequent understanding of why rhythmic patterns consisting of grid-ordered events are experienced as lacking a human touch even when they are produced by a human. Rhythmic subdivisions that are too evenly played still tend to make us think of a machine. Loose timing, on the other hand, tends to be described as organic and evokes associations with human performance, even when those patterns and variations have been generated by a computer.[5]

The mechanistic aspect of perfectly even timing in sequencers from the predigital and early digital era was often countered through the introduction of a humanizing function to it, by altering the beats of a musical sequence according to a random series of deviations that would make them less, nonhumanly perfect. However, even though this may be thought to match motor and timekeeper noise in human timing, such random deviations are not typical for groove-based music, that is, music organized around a repetitive rhythmic pattern. As many studies have shown, deviations in

groove-based music are to a large extent systematic (Bengtsson et al. 1969; Butterfield 2010; Danielsen 2006, 2010b; Iyer 2002), meaning that the same pattern of microtiming (that is, the early and late marking of beats) is repeated in each repetition of the basic pattern (usually one or two bars in length).[6] Research has also shown that in performed music fluctuations that exceed this basic pattern are not random either but are instead both long-range and correlated (Hennig et al. 2011).

Prior to the increased temporal flexibility of later digital sequencers and digital audio-sequencing (which was introduced in the early 1990s, see Brøvig-Hanssen and Danielsen 2016, chap. 6; Burgess 2014, chap. 11) then, there was both an ideological and a de facto difference between played and machine-generated rhythm that was associated with the constraints of the conditions of production within these two spheres. Machine rhythm lacked the intended (and unavoidable nonintended) temporal and sonic variations that were typical of human performance. Likewise, humans were simply unable to produce the extreme evenness of the machine.[7]

As we shall see in the following section, this traditional link between machine-based music and stiffness has been disrupted by new opportunities for creating microrhythmic designs in the DAW—first, because the DAW seems to be able to produce the entire spectrum of rhythmic feels previously associated with human performance, and second, because human- and computer-based rhythms are often, in fact, deeply embedded in one another, not least through the ways in which human performances are routinely used as raw material for producing rhythms in the DAW. Today, therefore, it is very difficult to distinguish between human- and computer-generated performances. Nonetheless, even though the division between human- and machine-based rhythms has been transcended when it comes to what the machine can actually produce, the two related aesthetic paradigms—even rhythm on the grid, on

the one hand, and deep, groovy rhythmic designs, on the other—have to some extent been continued. At the mechanistic extreme of the rhythmic continuum, we find forms of electronic dance music (EDM), in which machine-like timing is a distinguishing stylistic feature and even a preference long after alternatives to it had become available in the early 1990s (Zeiner-Henriksen 2010). At the "organic" extreme of the continuum, we find the deep, groovy rhythm of African American–derived, computer-based rhythmic genres. What is used to realize these two fundamental rhythmic inclinations, however, is no longer so different because, in the age of the DAW, they typically come from the same production tools. A crucial factor in defining a possibly new late-digital condition regarding the field of musical rhythm, then, is the manner in which the distinction between organic and machinic rhythm has been transcended. Agency and automation, understood as creative strategies, inform *both* mechanistic rhythmic expressions and deep, groovy feels. I will now conduct a closer inspection of these two aesthetic trends in contemporary musical rhythm.

Microrhythmic Manifestations of the Digital Audio Workstation: Two Trends

The first trend comprises electronica-related styles whose rhythmic events align with a metrical grid. Common to the musicianship of the artists representing this trend is a preference for exaggerated tempi and an attraction to the completely straightened-out, square feel of quantization. As pointed out earlier, this was both an aesthetic preference and a technological constraint in the analog, sequencer-based tradition that this trend grew out of. In the early days of this trend, high-pitched sounds such as the

hi-hat cymbal (or something else that fills the same musical function) were programmed unnaturally—either too quickly or too evenly or both—specifically to connote a machine-like aesthetics (Zagorski-Thomas 2010; Inglis 1999). The sound of these songs, then, evokes an overdone, even unlikely virtuosity that I have elsewhere labeled the "exaggerated virtuosity of the machine" (Danielsen 2010a). Prominent pioneering artists of this rhythmic trend include Aphex Twin (the performing pseudonym of Richard D. James), Autechre (Sean Booth and Rob Brown), and Squarepusher (Tom Jenkinson), all of whom entered the electronica scene in the 1990s and are associated with the label Warp. After a few years, this aesthetic strategy had traveled from these avant-garde electronica toolboxes to, for example, the title track of the Destiny's Child album *Survivor* (Columbia 2001), thus entering the popular music mainstream. The fast speed and quantized evenness of many of the tracks on such albums anticipate the related process of musical granulation—that is, of crystallizing "sonic wholes" into grains, so that musical or nonmusical sounds are chopped up into small fragments and reordered to produce a stuttering rhythmic effect. This aesthetic also promotes a tendency to transform sounds with an otherwise clear semantic meaning or reference point—such as a musical source or a different musical context—into "pure" sound (see, for example, Harkins 2010). Sounds or clips are also often combined in choppy ways that underline sonic cut-outs, rather than disguising them, resulting in a skittering collage.

The label *glitch music*[8]—a substyle of electronic dance music associated with the artists mentioned in the previous paragraph—hints at the ways in which we perceive these soundscapes, namely as a coherent sonic totality that has been "destroyed," meaning chopped up and reorganized anew.[9] An important point here, which Brøvig-Hanssen discusses at length, is that this approach to sound relies on the listener being

able to imagine a "music within the music"—that is, a fragmented sound presupposes an imagined and spatiotemporally coherent sound (Brøvig-Hanssen 2013). This operation, however, becomes particularly precarious when the manipulated element is a voice. Brøvig-Hanssen's detailed analysis of the manipulations of the vocal track in two versions of Squarepusher's "My Red Hot Car,"[10] where one is a "glitched" version of the other, clearly demonstrates the ways in which meaning is transformed when sound is manipulated away from what one normally regards as the field of possible human utterances. In the glitched version, the vocal track has been "deformed"—sounds are cut off too early, there are repeated iterations of sound fragments separated by signal dropouts, and fragments are dislocated from their original locations (Brøvig-Hanssen and Danielsen 2016, chap. 5)—in a manner that clearly departs from the human. Still, it is also hard to hear the vocal track as purely musical (that is, not sung) sound. One tends to persist in imagining a human being (and a coherent message) behind the stuttering rhythm, since the voice always tends to be, first and foremost, an indexical sign of the human body and a clear path from source through musical performance to recording. Consequently, "[w]e can discern two layers of music, the traditional and the manipulated, neither of which, in this precise context, makes sense without the other" (Brøvig-Hanssen and Danielsen 2016, 95).

In addition to the association of cut-up-strategies with the destruction or transformation of a coherent musical whole, glitched, granulated, or manually or automatically chopped up sound also produces a very characteristic microrhythmic effect. As Oliver (2015) emphasizes, in jungle and drum and bass it is not first and foremost the transformation of temporal features or durations that produce the peculiar microrhythmic effects but the cutting up of *sounds* and the abrupt transitions

between sounds that such cuts produce. The effect of chopping up the crash cymbal of the much-sampled Amen break, for example, relies heavily on the fact that it is an initially acoustic, and thus very rich, sound.[11] When human musicking is transformed through computer-based procedures, one is thus confronted by both a break with and a continuation of the existing mechanistic aesthetics of some kinds of rhythm. The sound is different (richer, less pure), but the groove is produced, as with most EDM-related styles, not by manipulating temporal relationships but by introducing an interesting system of dynamics within the domain of sound. In the jungle genre, however, from which many of Oliver's examples are drawn, it is not the dynamics of one sound that are the foci, but rather the microrhythmic effect that can be achieved through a compelling montage of fragments of the sound—that is, through the disruption and reordering of the parts of a sound.

Whereas no microtiming is usually involved in this practice—all of the events are on the grid—a second trend, on the contrary, pushes the perceptual boundaries of timing discrepancies and irregularities to the limit and, in some cases, beyond. It concerns the increasing experimentation with, and manipulation of, the microtiming of rhythmic events through moving tracks back and forth on the time axis while otherwise cutting and reordering, editing and warping—in short, transforming longer stretches of sampled or played sounds. This trend produces rhythmic feels that are experientially very different from those above. Here, it is primarily the temporal relationships—durations, interonset intervals, the temporal envelope—that are being altered to great effect.

One way of manipulating the original timing of performed music is simply to move rhythmic events or whole tracks to new temporal positions. In the former case, the result can be severe discrepancies between rhythmic events that were initially

aligned (beatwise). In the latter case, moving an entire track in a multitrack recording introduces multiple locations for the pulse at the micro level. This strategy can be heard on D'Angelo's *Voodoo* album (1999). Inspired by the glitch aesthetic of legendary hip hop producer-artist J Dilla (more on his music later), many of the *Voodoo* tracks display sharp discrepancies between rhythmic events that are happening on the same beat. In the tune "Left & Right," for example, visual amplitude/time representations of the groove reveal that the discrepancy of the pulse location of the guitar layer and the pulse location of the bass/bass drum layer is between fifty and eighty milliseconds, or up to one thirty-second note at the song's tempo, which is close to ninety-two beats per minute (Danielsen 2010b). In an analysis of another song on this album, "Untitled (How Does It Feel)," Bjerke (2010) measures the distance between the multiple locations of the basic pulse at around ninety milliseconds. As D'Errico points out, the instability introduced through such a destabilizing maneuver tends to become normalized in the context of a stable and repetitive loop (D'Errico 2015, 283). However, such interventions nonetheless introduce a characteristic nonhuman, halting feel to the groove which, in turn, conveys the impression that the feel aspect of the groove is somewhat overdone.

The experimental hip hop and neo-soul coming out of the Soulquarian collective to which D'Angelo belonged, together with artists and bands such as Common, the Roots, and Erykah Badu, might be considered a form of the avant-garde within African American–derived rhythmic genres. However, recordings by more mainstream contemporary R&B and rap artists from the early 2000s display the innovative use of digital tools as well. Carlsen and Witek, in an analysis of the song "What about Us" from Brandy's innovative album *Full Moon* (Atlantic 2002, produced by Rodney Jerkins), show how the peculiar rhythmic feel of that tune

derives from simultaneously sounding rhythmic events that "appear to point to several alternative structures that in turn imply differing placements of the basic beat of the groove. Though these sounds might coincide as sounds, then, they do not coincide as manifestations of structure" (Carlsen and Witek 2010, 51). An illustration of this phenomenon would be, for example, when a hi-hat structurally referring to the last sixteenth note before a downbeat is delayed to such an extent that it coincides with the sound that in fact structurally represents that downbeat (a bass drum, perhaps). In other words, rather than being perceived as deviations from a shared underlying reference structure, such simultaneously sounding rhythmic events point to several alternative structures that in turn imply differing placements of the basic beat at the microlevel of the groove. The result is akin to the rhythmic feel of the D'Angelo groove described earlier, where there are multiple locations of the pulse that merge into one extended beat at the microlevel of the groove.

Radical warping procedures can also be heard on several tracks of Snoop Dogg's innovative album *R&G (Rhythm & Gangsta): The Masterpiece* (Geffen 2004). Here, several producers, among them J. R. Rotem and Josef Leimberg, contributed their takes on grooves where the feel aspect is almost overdone as a consequence of manipulation of rhythm in the DAW, leading to what I have earlier called the "exaggerated rhythmic expressivity of the machine" (Danielsen 2010a, 1). The groove in "Can I Get a Flicc Witchu" (produced by Leimberg) consists of a programmed bass riff and a drum kit, along with vocals that are mainly rapped. The texture of the groove is simple and open, but the microrhythmic relationships within it are muddy and complex. There are two forms of time warping going on here. First, the length of the beats is gradually shortened, so that beat 2 is shorter than beat 1, beat 3 is shorter than beat 2, and so on. This may be due to the use of tempo automation, a function

that was available in the DAW at the time of production of *Rhythm & Gangsta*. This form of manipulation contributes to a general vagueness as to the positioning of rhythmic events. Second, the bass pattern follows its own peculiar schematic organization and is a main reason for the "seasick" rhythmic feel of the tune. This pattern neither relates to the 4/4 meter nor conforms to a regular periodicity of its own (for a detailed analysis, see Brøvig-Hanssen and Danielsen 2016, chap. 6). Its peculiar feel has most likely been produced in ProTools after the recording,[12] either by adjusting the temporal onsets of the programmed events forming the bass riff pattern until the sought-after effect was achieved, by recording the bass riff separately in free rhythm, or by sampling the bass riff from a different source altogether. In the latter two cases, the recording or sample usually has to be deformed in various ways to fit the length of the repeated unit of the destination groove. The producer could also cut out a piece of the source (a recording or a sample) that has the exact length of the loop and paste it into the new musical context, regardless of any resulting mismatches in meter and tempo. This strategy recalls the work of J Dilla, and the sounding result in "Can I Get a Flicc Witchu" resembles the peculiar feels of Dilla's *Donut* album (2006), where the natural periodicity of the original samples is also often severely disturbed by the shortening or lengthening of one or more beats/slices of the sample. When this type of operation is looped, again, the result is a dramatically halting, deformed, human feel.

The Snoop Dogg example demonstrates some of the ways in which samples can be manipulated timewise through various warping procedures, the results of which resemble the effect of the (re)positioning of rhythm tracks and events typical of D'Angelo's music from *Voodoo* onward. An additional dimension of J Dilla's music, however, is the way in which he—despite transforming his sample in fundamental

ways—manages to keep the sample's world of associations somewhat intact. While he even disturbs human musical gestures by introducing glitches to their natural flow, his music is generally derived from the cutting and splicing of one or a very few sampled sounds, which allows them to remain readily recognizable. His work therefore contrasts with the "quantized" glitch aesthetics described above, where the automated procedures for cutting and splicing/relocating sonic fragments tends to destroy the sources and meanings of the samples. D'Errico also points to J Dilla's characteristic habit of reconfiguring single musical sources—that is, he often "abstains from juxtaposing various samples into a multi-layered loop, instead rearranging fragments of a single sample into an altogether different groove" (D'Errico 2015, 283). This strategy underlines the surreal effect of the glitched version of the sample and shows the extent to which the meaning of the end result in such cases is highly parasitic on its source. When a sample keeps enough of its character to point toward its original aesthetic universe, which in the case of Dilla is often a world of easy listening or light entertainment**,** the effect of the "corrupted" sound file or the imperfection of the loop becomes conspicuous.

Benadon (2009) notes that time warps are common in predigital music as well. In early jazz, for example, the original rhythmic template might be distorted (in performance) through acceleration, deceleration, or a combination of these within the time span of the template.[13] Global transformations of tempo might also affect the perception of stability of the rhythmic template, since all tempo transformations happen in relation to a rhythmic anchor and therefore introduce a sense of tension and release against that anchor. These forms of "analog" time warps, however, tend to have a continuous character.[14] They gradually (organically) evolve, whereas digital time warps, probably because they are not implemented and modified by human

musicking, tend to be introduced more abruptly and are thus often heard as un-organic or glitched.

Both trends described above are parasitic on our notion of a pre-existing musical whole—something that was not deformed has been twisted or bent, a whole has been cut up and reordered, something that did not show any sign of failure or defect has been manipulated to come forward as containing a glitch. The perceived nonhuman character of these digital manipulations presupposes a notion of musical humanness—that is, an imagining of what the typically human gesture that has been disturbed or destroyed once was.

An Extension of the Human?

Playing and making music have always been embedded in technology. The opposition between organic and machinic musical expressions in late 1970s and early 1980s popular music thus comes forward as partly ideological: all music-making means being deeply involved in its technology, or, in the words of Nick Prior:

> It is not just that technology *impacts* upon music, *influences* music, *shapes* music, because this form of weak technological determinism still implies two separate domains. Music is always already suffused with technology, it is embedded within technological forms and forces; it is *in* and *of* technology. (2009, 95)

Relating this point to a more general epistemological discourse, we could say that new technology creates new understanding, and that we have always learned to know the world through the tools and technologies that we use to interact with our surroundings. As Heidegger makes us aware of in his essay “The Question

Concerning Technology" (1977), there is no alternative route to the knowledge we acquire through technology. Moreover, the insights that we derive from technology cannot be separated from the technology itself; through technology we achieve knowledge about the world in a way and to an extent that would otherwise be unavailable to us. In the words of Heidegger: "[*Techne*] reveals whatever does not bring itself forth and does not yet lie here before us, whatever can look and turn out now one way and now another" (1977, 8). The idea that man and technology are opposed to each other is thus, according to Heidegger, beside the point—instead, the machine should, in line with the "technology as prosthesis"–view presented earlier, be seen as an *extension* of the human.

Digital technology has reactualized this debate in music-making, and from this perspective one might ask whether the rhythmic feels discussed previously really represent the results of a radically new "posthuman condition," or whether they ought to be understood as part of the continuous development of technology's ever-present role as an aid to, and extension of, human expression and behavior. According to the latter position, so-called posthuman expressions are not after or outside of the human repertoire at all. Instead, they should be considered simply the most recent expansion of that repertoire. This would mean, in turn, that the microrhythmic manipulation made possible by the digital audio workstation represents, in principle, nothing new, because there is nothing new in the fact that new technology produces new forms of knowledge, expression, and behavior or that it expands the scope of the human imagination.

As pointed out at the start of this chapter, however, after the introduction of sequencer-based grooves in the popular music mainstream in the late 1970s, performed and machine-generated music tended to align with two distinct aesthetic

fields. For some years, these two fields made use of different sets of tools that produced very different sonic results. Consequently, performed and machine-generated music came to represent different worlds of musical expression and imagination in the following decades. Microrhythmic manipulation in the DAW has brought about a new aesthetic situation marked by convergence between these two musical-rhythmic poetics. Performed and machine-generated music are, in the late-digital era, deeply embedded in one another—first, because both digital and traditional music technologies are used to achieve the desired musical results in both domains, and, second, because the respective contributions of these different technologies are in many cases (such as the examples discussed in this chapter) almost impossible to distinguish from one another in the end result. Accordingly, it would be wrong to speak of a hybridization of the two, because this presupposes two separate and still recognizable entities that have been combined. Rather, performed and machine-generated rhythms have, in many contemporary genres, morphed, making it impossible to separate their respective influences. We are most likely yet to see the full consequences of this development, which also includes a wide range of new interfaces for organic control of computers and music machines.[15]

The flexibility of the DAW, our contemporary music machine, has contributed tremendously to this ongoing transformation, from an either/or to a both/and where the distinction between organic and machinic musical expressions feels of little relevance. The timing of musicians is warped in the digital audio workstation, then copied by other musicians who are in turn manipulated in new machine-generated renderings, and on it goes. Even the very current examples of the creative usage of digital pitch correction illustrates this point. Autotune is another instance of a fundamental morphing of human and machine that is made possible by digital tools

that have extended the human expressive repertoire; sometimes the result of this morphing is a voice that captures certain human states or conditions better than the unmediated human voice, which is perhaps the most human of all instruments (see Brøvig-Hanssen and Danielsen 2016, chap. 7). We might then wonder whether we are in a new phase in the interaction between the musicking human and the machine, a phase that is characterized by an even more radical undermining of a possible ontological separation between man and technology than what characterizes the musician-instrument interaction typical of predigital times.

Imagining the "Humachine" through Sound

So, were the creators of the new rhythmic feels discussed earlier capable of imagining the end result (and its wider implications), or did these new feels simply arise by accident and become labeled as such by the collective imaginations of the consumers/receivers? This is a question that invites a double answer. No, the creators probably did not anticipate the effect of their experiments with new technology, and they were—and are, in line with Heidegger's insights above—certainly not capable of foreseeing their wider results. On the other hand, new rhythmic feels such as those discussed above do not simply happen. The processes leading to them are begun with the intention of creating new sound. Generally, mechanized procedures for generating new musical material represent a well-known strategy for innovative music-making that was employed by, for example, the composer Pierre Boulez from the 1950s onward. His practice and reflections make it clear that the point of using such procedures was often to come up with something unimaginable, with completely new sonic raw material, that could then be shaped through intentional compositional

procedures (see Guldbrandsen 2011, 2015). The same goes for the creation of the rhythmic feels discussed previously. As we have seen, an experimental attitude in combination with playfulness and creative abuse of new technology may result in as-yet-unheard sonic results.

The flip side of this is that, as soon as those new sounds have been produced, they start inhabiting the imaginations of their creators and the listeners. As to the groove-based music discussed in this chapter, the relationship between rhythm and motion is clearly a case in point. The groove qualities of rhythmic music are often related to the music's perceived ability to make one's body move. Exactly how various rhythmic feels are connected to body movement certainly remains an open question, but recent perspectives from the field of embodied music cognition pave the way for a close connection between rhythm and perceived and performed motion (e.g., Chen et al. 2008; Danielsen et al. 2015; Godøy et al. 2006; Large 2000; Leman 2008; Repp and Su 2013). Generally, discussions of the relationship between rhythm and corporeality in music listening point to the real and underacknowledged possibility that we structure our actual musical experiences according to patterns and models received from extra-musical sources, such as actual movements (see also Godøy, this volume, chapter 12). This is probably also a clue as to why we manage to adjust to and structure the peculiar warped grooves discussed above: we draw on our internalized repertoire of already acquired gestures to make sense of a new timing pattern. Put simply, if we find a way to move to those grooves, we then come to "understand" them.

However, not only do dance and movement affect the way we experience and understand grooves, inner or outer movements can also be induced or proposed by music; that is, new gestures can be proposed by a piece of music. The rhythmic feels

discussed earlier may thus be a means of imagining completely new movement patterns, or gestural designs, that are typical of the music of the *humachine.* Similar to the ways in which the glitched and warped grooves described above both evoke and deform their own "originals," such imagined gestural designs may feel at one and the same time connected and completely alien to us. As we develop ways of internally or externally responding to these grooves, however, we also develop an understanding of these new gestural imaginations, which at present goes well beyond our "natural" repertoire (here understood as what we regard as possible for human beings in the present historical situation). Sounds that are shaped by way of digital processing may thus evoke sonically based imaginations not only of the sources behind them (what kind of creature makes this sound) but also of morphed, human-machine motion. Put differently, the sound of the DAW proposes a wide variety of new and peculiar ways of singing (the morphing of human and machine through autotuning), talking (glitched stuttering vocal tracks), and moving (warped, deformed human gestures). Today, these are experienced as different and marked by technological intervention, but who knows? In future renderings, they might be regarded as completely commonplace, perhaps as ordinary as talking with people on the other side of the Atlantic through the telephone and hearing the whispering of singers from an enormous stadium stage are today.

References

Adorno, T. W. 1990. On Popular Music. In *On Record: Rock, Pop, and the Written Word*, edited by S, Frith and A. Goodwin, 301–314. London: Routledge.

Armstrong, T. 1998. *Modernism, Technology, and the Body: A Cultural Study*. Cambridge: Cambridge University Press.

Benadon, F. 2009. Time Warps in Early Jazz. *Music Theory Spectrum* 31 (1): 1–25.

Bengtsson, I., A, Gabrielsson, and S. M. Thorsén. 1969. Empirisk rytmforskning. *Svensk tidskrift för musikforskning* 51:48–118.

Bjerke, K. Y. 2010. Timbral Relationships and Microrhythmic Tension: Shaping the Groove Experience through Sound. In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 85–101. Farnham, UK: Ashgate.

Bowen, J. A. 1996. Tempo, Duration, and Flexibility: Techniques in the Analysis of Performance. *Journal of Musicological Research* 16 (2): 111–156.

Brøvig-Hanssen, R. 2010. Opaque Mediation: The Cut-and-Paste Groove in DJ Food's "Break." In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 159–176. Farnham: Ashgate.

Brøvig-Hanssen, R. 2013. Music in Bits and Bits of Music: Signatures of Digital Mediation in Popular Music Recordings. PhD thesis. University of Oslo.

Brøvig-Hanssen, R., and A. Danielsen. 2016. *Digital Signatures: The Impact of Digitization on Popular Music Sound*. Cambridge, MA: MIT Press.

Burgess, R. J. 2014. *The History of Music Production*. Oxford: Oxford University Press.

Butterfield, M. 2010. Participatory Discrepancies and the Perception of Beats in Jazz. *Music Perception* 27 (3): 157–176.

Carlsen, K, and M. A. G. Witek. 2010. Simultaneous Rhythmic Events with Different Schematic Affiliations: Microtiming and Dynamic Attending in Two Contemporary R&B Grooves. In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 51–68. Farnham, UK: Ashgate.

Chen, J. L., V. B. Penhune, and R. J. Zatorre. 2008. Listening to Musical Rhythms Recruits Motor Regions of the Brain. *Cerebral Cortex* 18:2844–2854.

Collins, N. 2003. Recursive Audio Cutting. *Leonardo Music Journal* 13:23–29.

Cook, N. 1995. The Conductor and the Theorist: Furtwängler, Schenker, and the First Movement of Beethoven's Ninth Symphony. In *The Practice of Performance: Studies in Musical Interpretation*, edited by J. Rink, 105–125. Cambridge: Cambridge University Press.

Danielsen, A. 2006. *Presence and Pleasure: The Funk Grooves of James Brown and Parliament*. Middletown, CT: Wesleyan University Press.

Danielsen, A. 2010a. Introduction. In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 1–18. Farnham, UK: Ashgate.

Danielsen, A. 2010b. Here, There and Everywhere: Three Accounts of Pulse in D'Angelo's "Left and Right." In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 19–35. Farnham, UK: Ashgate.

Danielsen, A. 2012. The Sound of Crossover: Micro-Rhythm and Sonic Pleasure in Michael Jackson's "Don't Stop 'Til You Get Enough." *Popular Music and S*ociety 35 (2): 151–168.

Danielsen, A., M. R. Haugen, and A. R. Jensenius. 2015. Moving to the Beat: Studying Entrainment to Micro-Rhythmic Changes in Pulse by Motion Capture. *Timing and Time Perception* 3 (1–2): 133–154.

D'Errico, M. 2015. Off the Grid: Instrumental Hip-Hop and Experimentalism after the Golden Age. In *The Cambridge Companion to Hip-Hop*, edited by J. A. Williams, 280–291. Cambridge: Cambridge University Press.

Desain, P., and H. Honing. 1989. The Quantization of Musical Time: A Connectionist Approach. *Computer Music Journal* 13 (3): 56–66.

Dibben, N. 2009. *Björk*. Bloomington: Indiana University Press.

Frith, S. 1986. Art versus Technology: The Strange Case of Popular Music. *Media Culture Society* 8 (3): 263–279.

Godøy, R. I., E. Haga, and A. R. Jensenius. 2006. Playing “Air Instruments”: Mimicry of Sound-Producing Gestures by Novices and Experts. In *Gesture in Human-Computer Interaction and Simulation: 6th International Gesture Workshop, GW 2005, Berder Island, France, May 18–20, 2004, Revised Selected Papers*, edited by S. Gibet, N. Courty, and J.-F. Kamp, 256–267. Berlin and Heidelberg: Springer-Verlag.

Guldbrandsen, E. E. 2011. Pierre Boulez in Interview 1996 (II): Serialism Revisited. *Tempo* 65 (256): 18–24.

Guldbrandsen, E. E. 2015. Playing with Transformations: Boulez’s Improvisation III sur Mallarmé. In *Transformations of Musical Modernism*, edited by E. E. Guldbrandsen and J. Johnson, 223–244. Cambridge: Cambridge University Press.

Harkins, P. 2010. Microsampling: from Alkufen’s Microhouse to Todd Edwards and the Sound of UK Garage. In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 19–35. Farnham, UK: Ashgate.

Heidegger, M. 1977. *The Question Concerning Technology and Other Essays*. New York: Harper & Row.

Hennig, H., R. Fleischmann, A. Fredebohm, Y. Hagmayer, J. Nagler, A. Witt, et al. 2011. The Nature and Perception of Fluctuations in Human Musical Rhythms. *PLoS One* 6 (10).

Horkheimer, M., and T. W. Adorno. 2002. The Culture Industry: Enlightenment as Mass Deception. In *The Dialectic of Enlightenment: Philosophical Fragments,* 94–136. Stanford, CA: Stanford University Press.

Inglis, S. 1999. 20 Tips on Creating Realistic Sequenced Drum Parts. *Sound on Sound*, October.

https://web.archive.org/web/20160327093715/http://www.soundonsound.com:80/sos/oct99/articles/20tips.htm. Accessed December 17, 2018.

Iyer, V. 2002. Embodied Mind, Situated Cognition, and Expressive Microtiming in African-American Music. *Music Perception* 19 (3): 387–414.

Jensenius, A, and M. J. Lyons. 2017. *A NIME Reader. Fifteen Years of New Interfaces for Musical Expression.* Berlin: Springer.

Johnson, H. 2005. The Cathedral. *Mix Magazine*, July 1. http://www.mixonline.com/news/profiles/cathedral/377333. Accessed December 17, 2018.

Kvifte, T. 1989. *Instruments and the Electronic Age: Toward a Terminology for a Unified Description of Playing Technique*. Oslo: Solum.

Large, E. W. 2000. On Synchronizing Movements to Music. *Human Movement Science* 19 (4): 527–566.

Leman, M. 2008. *Embodied Music Cognition and Mediation Technology*. Cambridge, MA: MIT Press.

Oliver, R. 2015. Rebecoming Analogue: Groove, Breakbeats and Sampling. PhD thesis. University of Hull.

Prior, N. 2009. Software Sequencers and Cyborg Singers: Popular Music in the Digital Hypermodern. *New Formations* 66 (1): 81–99.

Repp, B. 1996. Patterns of Note Onset Asynchronies in Expressive Piano Performance. *Journal of the Acoustic Society of America* 100 (6): 3917–3932.

Repp, B. H., and Y.-H. Su. 2013. Sensorimotor Synchronization: A Review of Recent Research (2006–2012). *Psychonomic Bulletin Review* 20:403–452.

Sangild, T. 2004. Glitch: The Beauty of Malfunction. In *Bad Music: The Music We Love to Hate*, edited by C. J. Washburne, and M. Derno, 257–274. New York: Routledge.

Théberge, P. 1997. *Any Sound You Can Imagine: Making Music/Consuming Technology*. Hanover, NH: Wesleyan University Press.

Zagorski-Thomas, S. 2010. Real and Unreal Performances: The Interaction of Recording Technology and Rock Drum Kit Performance. In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 195–212. Farnham, UK: Ashgate.

Zeiner-Henriksen, H. T. 2010. Moved by the Groove: Bass Drum Sounds and Body Movements in Electronic Dance Music. In *Musical Rhythm in the Age of Digital Reproduction*, edited by A. Danielsen, 121–140. Farnham, UK: Ashgate.

Notes

[1] For a discussion of how this crossover success changed black dance music, see Danielsen (2006, chaps. 6 and 7, 2012).

[2] According to Paul Théberge, contrary to the 1960s, when experimentation with, for example, distorted guitar sound and multitrack recording "created excitement around new sounds and electronic effects" (1997, 1), the late 1970s saw a skepticism toward electronic instruments. According to Théberge, this skepticism (among, one might add, rock musicians and their audiences) emerged as a consequence of the widespread reaction to disco (1997, 2).

[3] For a critical discussion of this polarization, see, for example, Simon Frith's essay "Art versus Technology" (1986).

[4] Interestingly, in an article in *Sound on Sound* as late as October 1999, this absence of variation in sound is still lamented when one is striving for realistic, sequenced drum parts:

"[A] main problem with many sampled sound sets is that they do not reflect the ways in which the sound of real percussion instruments varies depending on the force with which they're struck" (Inglis 1999). This uniformity is particularly acute with hi-hat strokes: "Standard drum kit sets, particularly those conforming to the general MIDI drum map, suffer persistent problems. Perhaps the most obvious of these is the use of only three different hi-hat sounds—open, closed and pedal—when real drumming makes use of a continuous range of sounds from quiet to soft, from tight closed to open" (Inglis 1999).

[5] Today, both machinic and organic music rely heavily on technological tools and is produced by way of the DAW. Whether a piece of music is placed in the one category or the other, then, has little to do with the kind of tools involved or the degree of technological involvement. Rather, it comes forward as a question of aesthetics and the degree to which the use of technology is exposed or made opaque to the listener (Brøvig-Hanssen 2010).

[6] In addition to such systematic timing, there are also individual patterns (see, for example, Repp 1996).

[7] The fact that humans make mistakes, and machines, on the other hand, are associated with (nonhuman) perfection, is also the backdrop for the experience of the "vulnerable," and thus more human, machine—as though technological mistakes somehow resemble our own imperfections. According to Sangild, a technological failure such as a glitch thus gives us a sense of "something living [it] displays the fragility and vulnerability of technology" (2004, 268). Dibben (2009) also underlines this humanizing effect of technological failure in a discussion of Björk's use of technology.

[8] "Glitch" initially referred to a sound caused by malfunctioning technology. As Sangild (2004) points out, these sounds of misfiring technology in fact expose technology as such (266), or render it opaque (Brøvig-Hanssen 2010).

[9] Whereas automated cutting processes could initially only be applied to prerecorded sound, they can now be used in real time. For an introduction to the algorithmic procedures

underlying different automated cutting processes in live electronica performance, see Collins (2003).

[10] The two versions were released as the two first tracks of Squarepusher's EP *My Red Hot Car* (Warp 2001). The second track was subsequently placed on the Squarepusher album *Go Plastic* (Warp 2001). [Comment from Anne Danielsen: Warp 2001 is a record label and should not be in the Bibliography.]

[11] The Amen break refers to a drum solo performed by Gregory Cylvester Coleman in the song "Amen, Brother" (1969) by The Winstons.

[12] See Johnson (2005) for an overview of the equipment used in Snoop Dogg's recording studio at the time.

[13] This phenomenon parallels the *local time shift* phenomenon as described by Desain and Honing (1989). See also Danielsen (2010a).

[14] "Analog" performance practice is, of course, also open to sudden transitions, for example in the form of tempo shifts. Research has shown that these can be rather abrupt (see, for example, Cook 1995; Bowen 1996). However, the particularly glitched character of digital time warps is difficult to achieve with conventional instruments.

[15] For an overview of advances in interfaces for musical expression from the last fifteen years, see Jensenius and Lyons (2017).