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The Instrument

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Figure 3.1 Pete Rock playing the MPC (Screenshot from: Rock 2006)

The 4×4 Matrix

When the hip-hop legend Pete Rock demonstrates one of his favorite instruments, the MPC, it is as if a magician is producing a big hit with a simple touch of his fingertips (Rock 2006). But the "instrument" does not appear very magical; it looks more like a specialized office machine than a traditional musical instrument with strings or keys. There is a

4×4 rubberpad-matrix, a number pad, knobs, button rows, a slider, and a small display. And indeed it has a quite bureaucratic function; it accesses an archive and rearranges and transforms parts of it. In this case, it is not located in an office handling an archive of invoices and contracts, but in a music studio and the archives are the crates of records owned by parents and friends. For example, one of the two songs from the video presentation, "Love is a Battlefield," is transformed from a long-outdated hit of the early 1980s (Pat Benatar 1983) into a hip-hop track with a new sound, new structure, and new vocals (C.L. Smooth 2007. Prod. Pete Rock; CD "The Outsider").

There are no secrets about the production and playing techniques of the instrument Pete Rock uses. It is a standard in new school hip-hop beat-making that goes back to the first widely available digital drum machines of the 1980s, the SP1200 (*S*ampling *P*ercussion 1987) and the MPC60 (*M*IDI *P*roduction *Ce*nter, 1988). But of course, as soon as it comes to the historical originals—as with classical instruments (e.g. the "Stradivarius"!)—myths exist about the nature of the hardware and the sound characteristics associated with it. While the SP1200 became a legend with its special 12bit-sound, the MPC became famous for its special timing and created a new instrument interface that has competed since then with the traditional chromatic keyboard controller in the area of sampling. Its 4×4-pad matrix renounces the representation of tonal structures from the beginning, even if it is possible to play melodies with the pads. Developed by drum machine pioneer Roger Linn, it does not provide piano keys but mini-drumpads for fingers. Samples are freely assignable to the pads, be it from percussion or melody instruments, or be it looped breakbeats. As with any sampler, it is possible to transpose everything on the fly, while the tempo of the sample to be played is being modified. Complete chords or motifs, hook lines and so forth can be tonally adapted to a new context or even played in chromatic sequences. Yet its focus is neither melodies nor tonal structures but the rhythmic playing, the temporal arrangement, and layering of heterogeneous preformatted musical elements. Pete Rock (2006) characterizes his work with the MPC as "a jigsaw puzzle" (1:25) that if it succeeds "sounds like a record" (5:33).

For me as a traditionally trained musician (guitar and piano), this instrument is an unfamiliar challenge. A traditional approach of direct instrumental mediation from body movement to specific characteristics of sounds does not lead further here. To form a sound with your finger movements or your breath flow, as on a guitar or a trumpet, is clearly not the purpose of the instrument. Hitting a pad on my "Maschine" (an MPC-derivative from Native Instruments, Berlin; I don't know if they followed the man-machine concept, but consequently, it is called with the German word "Maschine") "plays" an instrument or some "half-ready music" ("halbfertige Musik," cf. Großmann 2010) that I did not make myself. In technical terminology, I would say it triggers some fragments of music but if I begin hammering the velocity-sensitive rubber pads or if we watch Pete Rock turning knobs and hitting pads it is definitely more playing and grooving than triggering in a technical sense. And, as with any conventional instrument, the tones of the chromatic scale can be played—each pad can be assigned a playback speed of a tuned sample corresponding to the correct pitch. Nevertheless, this type of playing stands in contrast to playing a traditional instrument: It forms a different relationship of sound production to physical activity,

involvement, and musical structure. The MPC is an experimental machine that allows the user to playfully explore the aesthetic qualities of fragmentary and decontextualized material.

In the experience of playing with the MPC, there are more familiar and more alien things at the same time: the familiar playfulness, the instantaneous reaction, the felt gesture on the one hand; the alien missing feeling of direct sound shaping, the missing instrumental intonation on the other. Direct intonation is also what forces corporeality, discipline, and physical adaptation in traditional instruments. In general—including the traditional acoustic instruments—the whole process of tone formation is not directly controllable by the mind during playing, because elaborated musical structures are simply happening too fast. They require a trained predisposition, an automatism of motor processes. But these in turn—and here is the difference to the automatic processes of the machine—form a continuous labile state of balance between the human motor automatisms and consciously controllable action, and can thus be instantaneously modified. Instead, in case of playing with complex structures stored in or generated with machines, there is a stronger rational component, as the stored and automatically running processes with their option spaces are constantly there to think along with during playing. This difference, when it is not used sensibly and reflected by the player, causes unsatisfactory aesthetic results. Of course, this new type of requirement can and must also be trained; new skills must be developed and learned. This also clears up the misconception that one does not have to acquire any skills in order to make music with machines (which seem to play automatically perfect music), which is often cited as a flaw of the new practice—the idea being that only music of inferior quality could emerge from a practice of such crude play.

But here we are focusing not on virtuosity but on a new relationship between playing a musical instrument and music. I would call it second order playing: the performance of building new structures with fragments, chopped out of already existing structures. It transforms recorded sounds and allows a trial-and-error approach to form new configurations of several parts playing a rhythmic musical performance. Its greatest difference to conventional instruments results from breaking with a simulative drum machine tradition. While its predecessors, the LM-1 and the LinnDrum, were intended to replace a drummer in a band, the MPC—as its name "Production Center" reveals—is a phonographic workstation that focuses on montage and rhythmic composition. The LM-1 was the first sample-based drum machine developed by Roger Linn, introduced in 1979 and announced by Linn Electronics with the slogan "Real Drums at your fingertips." It was followed in 1982 by the widely popular LinnDrum and 1988 by the first MPC. In the use of DJ-Culture, something fundamentally new emerged from this machine: an instrumental device for recombining fragmented archives. The current MPC derivatives like the "Maschine" (see above) or the "Push" (Ableton, Berlin) further develop this aspect by continuing the merging of instrument and computer and offering a combined unit of laptop, software, and interface.

The interaction of soft- and hardware opens up a supplementary field of practical options and theoretical discussion. It is by no means clear whether this breakup of hardware features actually offers an advantage for the instrumental play. The question of

the relevance of the standalone character of electronic hardware instruments plays a central role in the discourse on the body–technology relationship in an advanced technocultural future environment and—as with the "running status" of music and the implicit rationality of instruments—will be discussed later.

To sum up, sound formation as an expression of emotional sensitivity or interpretative significance thus recedes here in favor of a combinatorial rhythmic experimentation in a "puzzle situation." But it is a great experience and can be a lot of fun—just like playing a traditional instrument. Of course there is a mental gap between a traditional approach and instruments with these new technocultural configurations. In this situation, it is helpful to become aware of the fact that the built-in cultural and musical knowledge of the MPC belongs to a specific universe of music making, to the technocultural hybridization of everyday music.

Playing Phonographic Material

This type of instrument is not only important as subject of research because it has established itself as a standard controller and generated a number of derivates. It was created in the 1980s, the historical period of transition from analogue to digital studio technology, and it represents a profound change in the relationship between human, instrument, technology, and musical composition/performance, its *Gestaltung*. The commonly used term "Sound Design" does not fit here, because a qualitatively essential activity is addressed, for which the terms composition, interpretation, and performance used to be valid and which are can be contained in a superordinate term of *Gestaltung*. In order to understand this process of transition and the corresponding practices of composition and shaping of musical material, it is necessary to precisely describe continuities and discontinuities. First, it stands for the shaping of creative instruments of the phonographic workbench, for an extended work with phonographic archives and sound material. Second, it stands for a current form of a (music-)instrumental playing a complex machine, for an elaborated interaction with generative automatisms. These two aspects are mutually dependent, simply because the basic procedure of phonographic reading and writing is not a culturally formed symbolic act as in musical notation, but a technical process. In this process, initially conceived as a machine-internal procedure, a human intervention takes place. Such instrumental access to the media-technical signal processes is at the core of the musical interaction with media devices.

This insight into the first aspect, the fundamental change of musical memorizing, archiving, and composing systems in the twentieth century, I owe to Friedrich Kittler's "Aufschreibesysteme" (1985) and "Grammophon, Film, Typewriter" (1986). From my point of view, Kittler's achievement is to have presented sensitively and in detail the consequences of a change in writing, or better cultural distribution and memory systems, from Gutenberg to computer data. However, some of these detailed descriptions lead to esoteric assumptions and misunderstandings—in this sense, the title of the English

edition with "Discourse Networks" (1990) misses the clear and striking statement of the original title. In our context, it is rather irrelevant whether the new recording systems really "write" in the literal sense of the word. They are technical systems whose storage media are mechanically "written" and "read." Here, reading and writing refer less to a practice of human symbolic transformation than to their cultural function of enabling a spatio-temporally independent availability of sound-events and the formation of archives. The suffix -graphy used since the nineteenth century serves as a familiar label, not for technical processes but for cultural functions. Talbot's "Pencil of Nature" or Edison's "Angel with the Pen"—which adopts the analogy of writing with a pen and engraving with the phonographic needle—are metaphorical images of the cultural appropriation of technical media with mechanical storage and access mechanisms (Großmann 2016). The musical instrumentalization of this mechanical writing accesses the technical parameters of the reading process; the technical signal flow is transferred to the level of human influence.

In the case of the turntable tradition of DJ-Culture, this is literally done by manually manipulating the movement of the record and pickup. At the same time, the mixer with crossfader, filters, and effects interrupts the signal path to the amplifier and becomes part of the "DJ setup" consisting of two turntables and a mixer. This tradition goes back to the dub-mix of the Jamaican sound systems, where the mixing desk and various effect devices form the haptic instrumental objects of the live performance (Williams 2012). If we are talking about an instrument here, it is the complete configuration, which partly comprises media equipment that have been used other than intended. The MPC, in contrast to the turntable and the mixing console, was neither thought of as a simple recording nor a playback device; it was designed as a simulation tool for drum and percussion tracks and a production workstation (as mentioned above). But the hip-hop community used it from the very beginning to intervene in the digital code, to rearrange and transform it, to make it playable. They were inventing a new instrument for playing music with phonographic archives:

> [T]he hip-hop musician's instrument, the sampler, is a piece of studio equipment. This simple fact totally obliterates conventional distinctions between performing (or practicing) and recording. (Schloss 2004: 46)

Of course there are more or less developed approaches pointing in this direction. Following Simon Frith, from the perspective of music technology "the history of music can be divided into three stages, each organized around a different technology of musical storage and retrieval":

> In the first (or "folk") stage, music is stored in the body (and in musical instruments) and can only be retrieved through performance … In the second (or "art") stage, music is stored through notation. It can still only be retrieved in performance, but it also has now a sort of ideal or imaginary existence … In the final (or "pop" stage), music is stored on phonogram, disc, or tape and retrieved mechanically, digitally, electronically. This transforms the material experience of music. (Frith 1998: 226f)

The passage quoted shows that the immense significance of this change of storage media has been recognized and that an epochal classification is already part of the discourse.

However, it is not helpful to assign only some styles, stories, or particular cultures ("pop") to these epochs, since they refer to all areas of musical practice in this new technical-cultural space. As a "final stage"—or better: a current phase—of the rationalization of instruments, phonography and algorithms are a general condition beyond genres or music-cultural categorizations. To classify the resulting practice as pop, mainly because it concerns the media formerly discussed under the label "culture-industrial," makes little sense. So it is, for example, also for "serious" or "avant-garde" music both a prerequisite and a design tool to apply phonographic technologies and strategies such as sampling, layering, remixing, and so forth. Even a seemingly purely acoustic musical event is—staged in media environments as an "unplugged" transmission—a media phenomenon; it uses the mechanisms of digital postproduction (equalization, filtering, compression, etc.) and is processed by the respective subject in a media-specific situation as an individual media reception.

The considerations so far lead directly to media theory and to discourses on instrumental rationality, knowledge, and agency. These aspects are precisely the topics that make the question of the transformation of musical techno-instruments interesting from a broader anthropological perspective. It is not just a question of a specific instrument and a specific genre. It is about the human interaction with technical environments that goes beyond purely purposeful control. Traditional musical instruments have always been "extensions of man" in the almost intimate sense of the coupling of motor skills, sensory skills, cognition, and technology, not to mention their complex emotional implications. They are media in a McLuhanian sense (McLuhan 1964), not of everyday life but of aesthetic experience. Their function is explorative, searching, testing, and playful. When media technology is used as an instrumental configuration, it at the same time unfolds its own agency. This media reconfiguration of the inside and outside, the "self-world of the apparatus world" (Dunn 1992) and its visible surface, eludes the regime of everyday practicality and opens itself to access to aesthetic play. This is also the reason why in McLuhan's perspective the artist's sensorium is the only one capable of perceiving and reflecting the medium and its transforming effects as such (McLuhan 1964: 31). McLuhan is also the one who, with reference to the ambivalence of extension and amputation, describes the painful losses associated with new media and technological "tools." Technological rationality here is directly linked to bodily processes and opens up a new spectrum of options through rule-controlled functions, but it also imposes strict limitations. Aspects of cognition, "thinking," and acting are delegated here to machine instances, whose framework conditions simultaneously expand and limit the existing optional spaces.

Media-theoretical positions like this correspond very closely to a well-known position in the traditional view of musical instruments, whose role can be summarized "as *mediators* between the performer's body and the sound they produce" (Hardjowirogo 2016: 15, original emphasis). Their sounding bodies replace or expand the human body for sound production and thus become an intermediate instance between a genuinely human and an instrumental sphere. As David Burrows attempts to outline for traditional instruments with the term "transitional objects" (1987: 121f.), they are specially shaped external objects that have a "strong link to the body" (ibid.: 119) and transform physical

and mental states into the realm of musical art. Like a mask "an instrument replaces the performer's own sonic face, the voice, with a proved impersonal sound used only for making music" (ibid.: 122).

The more these instruments are technically shaped, the more apparent their preformedness contains a powerful momentum of its own or (with Bruno Latour) "agency," then this creates the conditions for the musical process. Traditional discourses of the musical instrument also take into account its implicit agenda, its framework for possible performances, the hidden knowledge about musical shaping and composition that dwells within it. One of the most influential thinkers of the first half of the twentieth century, Max Weber—who as an astute observer of the socio-economic conditions of industrialization and rationalization provides the basis for many other theories (such as those of Theodor Adorno)—characterizes the conception of instruments as a decisive moment for the development of a system of musical tonality:

> Historically the rationalization of tones normally starts from the instruments: the length of the bamboo flute in China, the tension of the strings of the kithara in Hellas, the length of the strings of the lute in Arabia, of the monochord in Occidental cloisters. In their respective areas these instruments served for the physical measurement of consonances. (Weber 1958: 94)

Industrialization and the division of labor led to another decisive step in rationalization, the machinization of the world in which we live, work—and play music—for which Max Weber already discovers early signs with the church organ in the world of music:

> The organ is an instrument strongly bearing the character of a machine. The person who operates it is rigidly bound by the technical aspects of tone formation, providing him with little liberty to speak his personal language. The organ followed the machine principle in the fact that in the Middle Ages its manipulation required a number of persons, particularly bellows treaders. Machine-like contrivances increasingly substituted for this physical work. (Ibid.: 117)

It is not only the loss of freedom to "speak his personal language," but also the McLuhanian dialectic of enhancement and amputation that is addressed here. The almost superhuman "divine" power of the church organ is paid for with a physical alienation from the shaping of the tones, the splitting into playful control and technically fixed sound production without direct bodily influence on the physical factors of tone formation. With these aspects—rationality and control—already two central concepts of the development of algorithms and automation in "machine instruments" are specified. Weber traces their emergence farsightedly and identifies them as basic elements of progressive instrument development. Another fundamental factor could hardly be recognized by Weber, since—beyond the first compositional experiments in the 1930s—it did not establish as a broad practice until the second half of the twentieth century: phonography as compositional and performative literacy, which—as described above—is part of a new technical environment. Rationality and control of these media machines and musical instruments no longer refer just to precise tones and clockwork-controlled mechanical time grids but encompass the complete palette of acoustic-physical processes. This already applies to analog phonographs

and gramophones with their—desired or undesired—pitch and time manipulations, but is established entirely by electronic audio technology from amplification and sound effects to the microsecond-grids of digital phonography.

In digital phonography, with its discrete listings of measured values, the new materiality of phonographic writing as a representation of the sounding "reality" changes into a symbolic state. Thus, as with the discrete pitches symbolically represented in the notation, the sounds themselves can now also be subjected to calculatory rationality and technical control. Digital sequencers and DAWs use this new phonography for integrated environments for auditory design and thus enter a further level of rationalization, that of the universal medium computer. The integrated automatisms make these technologies seem to play by themselves; they access already played material and generate and process sound sequences. Agency here is not only a quality to be discovered through intensified awareness, it becomes directly and unmistakably perceptible as an instrument's independent sounding action.

It can be also helpful for the understanding of machine agency to give an interpretation of Mark Butler's book title *Playing with Something that Runs* (Butler 2014). Music always "runs." Something that is ongoing and happening independently of the player is not unusual; on the contrary, it is the normal state of the musical flow. For instance, the challenge in jazz is not only the spontaneous composition of an improvisation line, but also the constant perception of the ongoing interaction and the continuous harmony framework, an almost sporting achievement. In this respect, there is no fundamental difference to a running sequencer. But the sequencer is a running *machine*, that's the crucial difference. So what is really meant here by Butler is "playing with a running machine," that constitutes its own framework and processual flow. The machine becomes a new participant in this playful musical interaction.

Instrumentality

The crucial question for fundamental changes in the relationship between human beings and instruments that produce and shape sound remains: In what respect are the media and music machines of the twentieth and twenty-first centuries "musical instruments" and what new quality do they constitute in this respect, does it go beyond the perspective on instruments already discussed in traditional discourses?

Current academic literature is certainly concerned with the phenomena mentioned, their aesthetic objects and transformations, but—despite the "performative turn" proclaimed—the instrument and its performative access to recorded sound and algorithms remains strangely under-explored. However, there are some exceptions and more recent approaches that also form parts of the framework for my contribution here. First, there is the area of the recording itself and phonographic material. Since the 1980s, there has been scholarly debate about the "studio as a compositional tool," starting with a lecture by Brian Eno that describes his reflections on the role of creative work in the studio. In this context, the character of recordings as composed and fixed works has been considered, as opposed

to the rock song (Gracyk 1996). Paul Théberge sees—similar to the positions discussed here—a "fusion of instrument and recording device," hardly surprising in view of the spread of samplers as playing instruments beginning in the early 1980s. After discussing the existing positions, Butler uses the term "recorded text" to characterize the new materiality for musical creation, before approaching instrumental examples for "performing performances" (Butler 2014: 27ff., 65ff.). A broad discussion of current approaches can be found in the anthology *Musical Instruments in the 21st Century* (Bovermann et al. 2016), which allows me to summarize some positions elaborated there and to focus on specific problems.

In our context, this step from phonographic materiality to the identification of technical devices as instruments and their performative characteristics is decisive. Yet the relevance of this aspect is undeniable: as with classical instruments, it is the key to the specific processing of musical material and the qualities of the resulting aesthetic process. And a perspective on being a media device or a musical instrument is not only important for understanding the cultural practice of music but is also the subject of the definition regimes of the social groups involved. "Serious" and "popular," high and low culture are striving to distinguish themselves from one another by means of genres and styles, but also by means of their creative tools—for example the habitual difference of a violin player and a DJ. As can be seen from the stages model of media storage cited above (Frith 1998), such classifications also occur in critical discourses, even if procedures and techniques are already used as part of an overarching practice. But in this technocultural field innovations often reverse the highly culturally proclaimed order: pop culture here does not follow a preceding explorative "avant-garde" elite but establishes new practices itself—innovative pop and "serious" artistic scenes follows and use, often differently than intended, widely established pop-cultural aesthetic strategies with their corresponding media technologies. Whether such a creative environment is included in the (academic) canon of the established instruments or not has an impact on musical practice, curricula, and offerings of public educational institutions such as music schools and universities. The decision to treat media technology environments as instruments is also a commitment to liberate the technological practice of music from the notion of consumerism and cultural industry and to take it seriously as a culturally relevant creative field.

But what are musical instruments? How does a sound (re-)producing device become a musical instrument? Here an approach is necessary that avoids the misunderstandings of an ontological assignment: To be an instrument is—especially from a transcultural point of view—not a question of the "nature" of an object but of the perspective from which it is viewed. A turntable, for example, *is* neither a reproducing device nor a musical instrument, but gains the respective attribution through its use. Being a musical instrument is an attributed property, which can be assigned both dynamically and gradually. Depending on the goal, the investigation of this property can be useful or not. This rethinking of the term leads to a new conception in the direction of an instrumental quality: *instrumentality*.

> This specificity of musical instruments as distinguished from other sound-producing devices is expressed by the concept of instrumentality, which … seems to be a graduable

> and dynamic concept that is not tied to an object per se but is rather a matter of cultural negotiation. (Hardjowirogo 2016: 12)

Starting from Philip Alperson, who from a philosophical perspective coined the concept of instrumentality as a characteristic of music itself, the properties and contexts of musical instruments are an elementary part of musical practice:

> [O]ntologically, musical instruments need to be understood as musically, conceptually, and culturally situated. Or, to put the matter more formulaically, I wish to argue that musical instruments must be understood as instrumentalities in the context of human affairs … [T]he conception of musical instruments I have been advancing has implications for our understanding of music itself as a particular human practice, or perhaps more accurately, as a set of musical practices. (Alperson 2008: 47f.)

This approach, combined with Burrows' already cited concept of "instrumentalities" (1987), makes it possible to go the next step and ask for the special properties and the instrumental characteristics of the devices addressed in our context. The twofold role of media devices, which can be seen both as reproduction devices on the one hand, and as instruments involved in the process of musical creation on the other, is particularly problematic here. Instrumentality can only be achieved if they are thought of as part of a performance that is not dominated by a reference to another performance but which enables an independent creative act. This possibility seems to be so far away from Western thinking that an independent media performance can only be thought of to a very limited extent. As in Thomas Mann's chapter "Fülle des Wohllauts" ("Fullness of Harmony") in his novel *Zauberberg* (1924), the gramophone is conceived and staged as a "transitional object" that, in contrast to the corresponding object in Burrow's approach, does not target the here and now but evokes through technical magic the spiritual realm of a past performance. This use of a media device can already be seen as a performative act in itself, which constitutes a specific reception situation—but hardly as an instrumental performance. Another example is the introductory scene in *Performing Rites* by Simon Frith, which depicts a dinner party going on while listening to and talking about records ("Johan said, 'Let me play it to you!'," Frith 1998: 3f.). This specific situation of a performance of recordings is the starting point for the discourses of an entire book but is not recognized as a *musical* performance in itself.

With the focus on instrumentality, it is necessary to consider the electronic and digital media not only from the point of view of a reference to a performance that has already taken place. The liberation from the dominance of the media functions of reproduction and transmission is a prerequisite for understanding their instrumentality. Media devices produce sound and define production and listening situations. They form the environment for generating an individual aesthetic experience and are also controllable in the sounding parameters of their "performance" (such as volume, tone control, selection of excerpts). Alperson already grants—based on similar arguments—the playback devices the character of an instrument, as they are actively used as such, to determine the hearing situation and produce sound:

> Anything that can be utilized to bring the music to a listener can be regarded as a musical instrument. Radios, iPods, computers, high-fidelity stereo systems, in-store broadcast equipment, audio and video discs, and podcasts are all devices by means of which listeners may hear. (Alperson 2008: 44)

To summarize the preceding considerations: From my point of view, there are two steps that lead to an understanding of media devices as musical instruments. First of all, as explained here, it is important to recognize the performance character of the use of media devices. As a second step, their instrumentality in the sense of musical play is to be analyzed too. As the instrumentality discourse shows, it is not only the sound production that makes up an instrument in the sense of cultural practice. An investigation by Sarah Hardjowirogo identifies the following criteria that, based on a literature review, appear to be "crucial for the construction of instrumentality": "Sound Production," "Intention/Purpose," "Learnability/Virtuosity," "Playability/Control/Immediacy/Agency/Interaction", "Expressivity/Effort/Corporeality," "Immaterial Features/Cultural Embeddedness," "Audience Perception/Liveness" (Hardjowirogo 2016: 17ff.; in the following text these criteria are used as terms marked in italics).

With this background, it becomes clear that media devices can and should be understood as musical instruments if their use corresponds to the above criteria. In a phase of techno-cultural hybridization, familiar patterns and body relations of instrumental play dissolve. From this point of view, the MPC is an early prototypical step on the way to renegotiating the term "instrument," in which these devices "blur the boundaries between something we are prone to call 'instrument' and other categories such as 'medium', 'system', 'configuration', 'machine'" (ibid.: 10). Its instrumentality is its character of playing with sounds in a direct interaction, which corresponds to the mentioned categories, especially the core criterion of *playability*. And of course its *cultural embeddedness*, a property that many electronic instruments lack, is clearly visible: the well-established role of the MPC interface in the current cultural practice of music—the new school of hip-hop. "Sampling is playing with sound, or playing sound—like it's like an instrument, or a game" (Chuck D, as quoted by McLeod 2015: 85).

Player Pianos and Interfaces

From the point of view of musical tradition, playing a running machine seen as is in opposition to playing a musical instrument. In Western European art music, the musical instrument is a tool of the performer that allows an individual to unfold the structure of the work as an acoustic event in time. As performer, they stand as an important autonomous element in the chain between score and recipient. As soon as the instrument contains a part of the score, either as a running program (as with a pianola, other musicautomata, or digital software) or as a sounding music structure (a DJ's turntable or a sampler), the traditional division of composition and performance, which includes as an essential

moment the independent interpretation of the structure defined in the score (the work), is broken through. "Performing performances," as Butler aptly puts it, would be a paradoxical action.

But, as previously mentioned, the performance of music with media machines and programed sound generation has a prehistory. Long before electronic instruments, the keyboards of fortepianos and the organ decoupled sound production from direct human touch. The play of music automatons via manual operations such as turning a crank or winding a coil spring also have also a long tradition, for example in the operation of barrel organs and musical clocks. These reproduction instruments, musical automata, or music boxes that—like running MIDI-sequencer programs—play "by themselves," were always treated as special cases in the history of instruments. But there are some occurrences where reproduction instruments are played in an individual performance like "real" musical instruments. Thus, there is a missing link in the history between playing technically complex mechanical musical instruments, such as the organ or the fortepiano, and the electronic and digital self-playing instruments such as sequencers, samplers, drum machines, or groove boxes: the historical phase of playing self-playing automatons such as pianolas and self-playing pianos ("player pianos"). Playing a piece of playing equipment, of running machines—that is, what I have called "second-order playing" above—is in fact a fundamental difference that repositions the question of instrumentality in the history of musical instruments. Such a differentiated play, which touch on the border of advanced instrumental play, emerged with the development of ever better pneumatic playing mechanics for player pianos at around the turn of the twentieth century.

A new kind of machine-playing instrumentalist emerged at this historical moment: the pianolist. With their piano-players (or "push-up pianolas"), by which the keys of the "remote" instrument were operated, pianolists gave concerts with the repertoire for which piano-rolls were available (Reynolds 1927). Not only was the expressive interpretation of concertante playing now possible with these machines but, and especially for the interactions with traditional ensembles, the essential elements human interpretation and adaptation in the form of dynamics and agogics was also feasible. Nonetheless, the era of the pianolists was limited and remains a more or less forgotten episode of media music history. With the Wall Street Crash of 1929, manufacturers and customers were reduced in numbers, while other media such as the gramophone and radio developed into overpowering competitors.

One of the last pianolists, Rex Lawson, still demonstrates at various events how artistic this performance with a piano-roll machine can be. It enables dynamics, agogics, and adaptations of tempo to an ensemble and, of course, an expressive action, comparable to performance on traditional instruments. Here, nearly all categories of instrumentality as stated above are easily applicable—except *cultural embeddedness*, since this practice remained in general existence only for a short phase and did not establish itself as a broad musical practice. Like the virtuosos of the Theremin (Clara Rockmore) or the Trautonium (Oskar Sala), the pianolists were bound to the continuity of their respective instrument's technology, which, however, could never establish itself in a larger market. Following exotic analog devices for the phonographic simulation of vocals and instruments like

the Chamberlin, the Mellotron, and Mattel's Optigan, in the 1980s digital samplers first became established as instruments of reproduction for a wide range of practices, from that of producers to non-professional users, as products of the consumers industry. They were able to draw on the already popular DJ-Culture that had developed outside the Western art music tradition. At this moment, it becomes clear that "consuming technology" (Théberge 1997) belongs to the dialectic of instrumentality; it simultaneously means complex reduction, conventionalization, and accessibility in a process of cultural-industrial rationalization.

If we examine the newer tradition of interfaces like the 4×4 matrix, we encounter a similar dialectic, which provides valuable insights for the development of digital instruments in the twenty-first century. In a historical phase that has been ongoing since the 1980s, in which the algorithms of digital control and sound generation can be directly influenced by data streams, the digital version of pianolas turn into "controllers" and the piano-rolls into pre-programmed software. An example of one of these lines of tradition would be the Slabs controller by computer-instruments pioneer David Wessel, presented at the NIME Conference 2009, which with its 4×8 or 4×6 pads has a matrix structure like the MPC. This interface, developed at the Center for New Music and Audio Technologies at the University of California, represents the characteristic approach of computer music to view the instrument as a sensory data source and is a natural culmination of Wessel's work since the 1980s on "composed instruments" (Freed 2016: 151). Unlike the MPC's 4×4 matrix of "little drumpads" intended for sample playback, whose output data correspond to the basic parameters of the MIDI standard (on/off; velocity), Slabs generates dynamic data streams in several parameters. The hardware of Slabs consists of a matrix of twenty-four or thirty-two touchpads, which are components usually built into commercially available laptops (such as the Sony Vaio). This construction also—as with the numberpad of the MPC borrowed from office machines—follows a logic of availability in the commercial consumer market, which here originates from the area of the home office and mobile business computing:

> The VersaPad semiconductive touchpad (by Interlink Electronics) is used to estimate the X and Y position and applied force (Z) of fingers touching its surface. It is usually used as a pointing device in laptop computers and in hand-written signature recognition applications. (Freed 2016: 153)

The concept is based on "using gestures as signals, not as just triggers" (Wessel 2009: 1:10). The data stream of up to ninety-six independent parameters directly generates the resulting sounds by mapping them to program components and audio data, which thus become an integral part of the instrument. As a human–computer interface, it stands between human action and sound generation and thus corresponds to the abovementioned "transitional object" without, though, producing sounds itself but actively executing parts of the composition. Composition and instrument merge in the arrangement of controller and software patches: "the patch in MAX/MSP is certainly another part of the instrument" (ibid.: 1:02). This concept is associated with an improvisational way of making music. Unlike Roger Linn, who is oriented toward pop and popular classical music, David Wessel's

Figure 3.2 David Wessel playing on Slabs. Screenshot: Wessel 2009.

approach is influenced by jazz and follows "the idea of composed improvisations using complex performance environments" (Akkermann 2013: 234).

Instruments such as Slabs have particular problems with some of the instrumentality categories discussed, such as *playability* and *learnability*. Even just the number of parameters there are to be controlled directly from the tips of the ten fingers exceeds the control characteristics of any other traditional instrument. Here complexity turns into a perceived arbitrariness—as already seen in the final phase of serial composition in the middle of the twentieth century (in works like Pierre Boulez's "Structures"). Its complexity counteracts the original intention of control; as a result, the device becomes hardly playable without a massive reduction of capabilities. In order for the instrument to be learnable at least in its basic features, it is necessary to dispense with the freedom of mapping and to introduce fixed relations between hardware and software.

These advanced instruments do not manage to reach the status of *cultural embeddedness* either, as they initially serve exploration and experiment, not a broad launch into the consumer market, even if they are intended as prototypes for actual new instruments. Virtuosity and repertoire are mostly limited to individuals or small groups focused on the compositional model implemented by the combination of hardware and software. An integration into any sort of broad cultural practice only takes place when such

instruments can tie in with an established compositional model and provide added value to conventional instruments. Even if the Slabs interface works in much more differentiated way from the technical aspect of dynamic control than the simple 4×4 matrix of the MPC, the less elaborated interface remains decisive in the practice of phonographic work and gains a higher level of instrumentality. The MPC was able to take up the existing practice of DJ-Culture and became a new instrumental standard. But there is no doubt that technical developments of advanced musical machines will play an important role in the practice of the twenty-first century. So, if such complex interfaces are to become musical instruments in the future, a fundamental broadening of the perspective and a rethinking of the relationship between machine and musician (in particular from the viewpoint of control) is necessary.

Playing the Programmed Future

The change in musical instruments is not only a phenomenon of individual genres such as hip-hop or EDM. In such genres the change becomes particularly clear: they are built on a DJ-Culture approach working with phonography or on producing tracks with sequencer-controlled electronic sound synthesis. Their instruments, such as turntables, samplers, synthesizers, controller interfaces, sensors, and digital audio workstations, established themselves in the second half of the twentieth century and can be found on most of the virtual surfaces of mobile devices in the twenty-first century.

In other genres, new music technology tries to tie in with familiar ideas. The most common role in the practice of Western European art music is the conductor who "controls" the orchestra. Here a simple hierarchical conception of "real-time control of music performance" seems valid:

> It is similar to the role of the conductor in a traditional orchestra. The conductor controls the overall interpretation of the piece but leaves the execution of the notes to the musicians. A computer-based music performance system typically consists of a human controller using gestures that are tracked and analysed by a computer generating the performance. (Friberg and Bresin 2008: 279)

Even if this view is evident at first glance, it contains a misunderstanding of both the role of the conductor and the role of the orchestra. The members of the orchestra are not machines that follow the movements of a conductor one to one and the conductor is by no means independent of the active participation of the orchestra. In fact, the concept quoted paves the way for an analysis of the conductor's intentions and the translation of these into a meta-code that acts on a set of rules for the individual sound generators. The prerequisite for this is to develop high-level descriptors that can be controlled via parameters. This requires a musically operationalizable knowledge at all levels, which however—and this is the main problem of this approach—is to be gained mainly at the level of the musical structure of specific genres, which are suitable for a transfer of their structure into abstract sign systems. These corresponding genres are, in an obvious way, the structures of Western

European art music or of scale-oriented jazz. However, it is not clear whether the (re-) search for such overarching rules and their algorithmic implementation, as provided by some "music similarity measures" derived from machine learning, for example, actually delivers on the promise of musical meaning.

> A lot of research on these issues is to be expected in the near future, driven by the sheer practical potential of music similarity measures. To put it simply: computers equipped with good music similarity measures may not be able to make sense of music in any human-like way, but they will be able to do more and more sensible things with music. (Widmer et al. 2008: 186)

This kind of research thus makes more sense when the perspective turns: the agency of the computer as a creative tool now becomes audible, independent of human criteria of meaning. This could lead to an exploration of auditory aesthetics by algorithms and automatic machines that goes beyond conceptualizing them as mere hierarchically subjugated tools. In a new kind of collaboration with machines, their own dynamics might provide novel aesthetic experiences:

> Machines can become more equal partners in heterarchic networks of human and machine actors. Giving them similar access to decisions opens intriguing possibilities: They can provide a variety of "director's input," from oracular hints à la Oblique Strategies, concrete instructions about playing roles, to directly switching the selection and configuration of the modules the human players are currently playing with. (Lopes, Hoelzl, and de Campo 2016: 358)

But there are some more and perhaps deeper doubts about the validity and relevance of this as a model for contemporary music.

> Our sense of mutability between performer, instrument and environment is heightened by our engagement with computers, and our confusion in this regard is evident in our vernacular with regard to their place in performance. We habitually refer to computers (and associated software, or just the software) as instruments. We refer to just the same elements as "performing or composing environments". And in some circumstances we imbue the computer with sufficient agency that we regard it as "performer". The incommensurability of digital hardware and software with the habitual divisions of "attention" or responsibility in musical practice may not have prevented much research into replicating the perhaps archaic notions of "conductor", "score follower", etc., but the extent to which such concepts inadequately represent the algorithmically-equipped world is clear. The uncertain status of current laptop performances, the activities within which may vary from simple event-triggering through to "live coding" is instructive here, the latter making distinctions between performer, instrument and environment particularly difficult to sustain. (Waters 2007: 4)

Let me continue and sharpen these considerations: a total control of musical performance resembles the promise of artificial intelligence to generate sonic results that perfectly achieve at the desired emotional effect—both represent a scientifically fascinating but aesthetically not satisfying goal. It equates designed sound with an algorithmic and accurately tuned, personalized medicine, the application of which is projected into a

fulfilment phantasm. Aesthetic practice would be reduced to the consumption of drugs, a simplified and radical version of the cultural-industrial model of society in the middle of the twentieth century. There is no doubt that methods such as deep learning, both in the analysis of notated structures and in the dynamic spectral analysis of audio material, can achieve results previously unattainable and that these can establish themselves as algorithmic tools, for example in studio production and performance. In the aesthetic sense, however, such applications only become interesting when they are played with, experimentally explored, and playfully experienced.

So, what are the consequences for the future agenda of instruments in a digital culture? Research on the technological progress of instrumentality cannot be limited to improving convenience and efficiency, but has much more far-reaching perspectives: it focuses on (a) digital play with the technical writing of phonography and aesthetic and creative access to the recording archives, (b) aesthetic exploration of the inherent dynamics and the networking of algorithmic processes, and (c) consideration of a new balance between musical playing, the disciplining of the individual and virtuality. While the first two points have already been described in detail, I would like to conclude by unfolding the last aspect that is crucial for future instrumental playing and the relation between the corporeality of musicians and the data space they interact with (and which corresponds to the abovementioned category *expressivity/effort/corporeality*).

Against developments such as Slabs, traditional instruments such as the violin seem almost archaic. This is due not only to their centuries-old practice, but also to the inherent culture of disciplining their players. In order for a violin or trumpet and the repertoire associated with it to become the extension of the body as mentioned above, a rigid process of adaptation and discipline, often accompanied by physical pain, is necessary. In a phase of human development characterized by technological means and possibilities, such problems can be overcome for a broad musical practice. The rigid retreats to which professional musicians are subjected already in their childhood years are not established in any other area of society apart from top-level sport, the legitimacy of which can equally be questioned. Western European art music and its performance conveys an instrumental ecology of discipline and subordination, values that do not fit the advanced Western societies. A playful music-making in this ecology of violence is—despite the promises of the music schools—doomed to fail. For today's "dilettantes," elementary parts of the classical-romantic repertoire are simply not playable. It goes without saying that the residual proponents of such an archaic physical practice continue to exist and reposition themselves as contraries in technical societies, but it is important to discover and develop a new culture of aesthetic play.

Perhaps it is necessary to give up aspects of the usual desired control and work with algorithmic machines in an open and non-hierarchical sense. This can—and it is already apparent in some respects—happen in two main ways. On the one hand, in a rigorous experimental practice, in the probing of instruments, that

> are quite evidently designed such that the ambition to master them becomes meaningless. If the very inner workings of the instrument change with each cable that is dis-/connected,

> predictability is gone in the blink of an eye. As a consequence, learning and performing cannot be separated, so the audience can witness the musician's learning process on stage; arguably a defining feature of experimental art practice. (Lopes, Hoelzl, and de Campo 2016: 351f.)

Here the point of reference is the artistic research of Peter Blasser, whose instruments fundamentally question a traditional approach in the sense of control and intention. On the other hand, another possibility is to tie in with more familiar, already introduced twentieth-century technical-cultural creative strategies, not in order to improve them in terms of efficiency and impact, but to playfully expand their limits and let their technicality itself emerge. An example would be Auto-Tune, which was designed as a correction algorithm for perfect vocal intonation and works in this sense as a standard now in pop productions and is also used as an audible sign of hybridization of a technical-cultural musical practice.

The task for current research is precisely this extension of perspective: in digital culture, music machines are no longer just controllers or tools, but challenges to the very anthropological conditions of aesthetic production. They are harbingers of a technocultural fusion, which are already thought of in the discourses of the post-digital, the post- and transhuman, and the "post-instrumentalities" (Lopes, Hoelzl, and de Campo 2016). We are in a situation of progressive anthropological change to a hybridization of human and technical environments, which can already be seen in music in everyday practice. Technicization, rationalization, and algorithmization have long been part of musical structures and thus of the aesthetic and emotional ecology of human beings. The far-reaching mechanization of musical composition and design has a prototypical character for other areas of human social and societal action. These aspects can be proven, analyzed, and reflected upon in the specific instrumentality of technical devices in the process of musical creation.