MACHINICALLY INFORMED MUSIC FROM THE PAST: Human performer vs. operational re-enactment (analog, digital)

[Extended] Version of lecture at Orpheus Instituut, Ghent, May 22 / 23, 2017, Focus Session *Challenging Histories*]

[Abstract]
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[Abstract]

"Many performer-scholars consciously seek to understand and recreate historical musics and practices" (thematic seminar draft). Still, not all musical practice which is from the past is necessarily historical: when the recorder and performer is not human but a machine such as the Welte-Mignon player piano rolls. From a techn(-*arche*)ological perspective, nonhuman piano play is not performative but operative; hermeneutic and re-interpretative human understanding of past music is replaced by *understanding media*. Even if any musical composition inherited from the past is irreducibly marked by "cultural, aesthetic, ethical, and even practical complications" (draft), there is no historical distance separating it from present re-enactment from the point of view of the functional machine enactment. Once the musician has been coupled to a recording machine, the record becomes neg-entropically timeless (in principle, set aside material obsolescence). The strategy of "emulation" (as has been developed to re-play vintage video games in retro-computing) may be evaluated a new epistemologic category for machinic music memory.

"Challenging histories" vs. "escaping history"

Let us start with a phenomenological prelude. *Artistic research* deals with past musical practices; "many performer-scholars consciously seek to understand and recreate historical musics and practices" (seminar draft). What actually has passed, is the unique acoustic embodiment of a musical composition in performative human variances, and the tuning of ears by musical theory. But musically (in terms of composition), there is no "historical" past at all. Günther Stern inquired the relation between music and historical time as expressed in his hablitation thesis *Die musikalische Situation* (which has been submitted in 1929/30 but rejected by Theodor W. Adorno). When listening to music "one falls out of the world"; nonetheless, "even in this hiatus, one remains in the medium

of time".[1] There is an a-historic *momentum* of experiencing time in listening to music (the aesthetic affect) and in experiencing presence-generating devices (chrono-phenomenological *aisthesis*): "Musikalische Zeit ist nicht geschichtliche."[2] Listening to music is a non-historic form of being-in-time.

But different from passive listening to music, humans, once actively coupled to a technical music instrument, are subject to its temporal *Eigenwelt*. Such a scene where humans and machines meet, in cybernetic terms, is a system.

Genuine sonic media theater, though, is a further escalation. A past musical performance is usually associated with the human performer. But there are musical performances which are rather operative for not bodily but machinic implementation. While a theatrical drama (time-ordered action) from the past can be re-enacted by humans (which is always individual performative re-interpretation), music machines do not re-interpret but re-operate, in equiprimordial repetition of the musical (symbiolic) or sound (signal) event. This is, then, no historical quotation or re-call, but a time-shift of the same class of sonic event.

Undoing musical historicity: phonographic signal "re-presencing"

There have been two ways to deliver music from the present to future: capturing the sonic signal by phonography (the analog way), and processing the musical symbol by discrete, that is in priciple: mechanizable notation (the "digital" way).

For the larger part of past musical activities, obviously there is a necessity of "historicizing", that is: indirect, contextual reconstruction of the past sound event, where technical (mechanic or electronic) recording and / or re-enactment is missing. In Villiers d'Isle-Adam's novel *L'Éve future* from 1880, regret is expressed for all the sounds which have been lost for posterity in the pre-phonographic era. The inventor of the phonograph, Thomas Alva Edison, laments: "Voici tantôt soixante-douze siècles <...> qui, d'ailleurs, à titre de précédent immémorial, controuvée ou non, eût échappé à toute phonographie."[3]

[With the technical recordability of the physically real of sound and images, human memory gets a sonic mirror effect (in Lacan´s sense), suspending the clear-cut difference between presence and absence, the present and passed times.]

In order to convince the audience of the sonic fidelity of phonographic recording, the Edison Company in 1916 arranged for an experimental setting in the New York Carnegie Hall: "Alone on the vast stage there stood a mahagony

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1 Stern 1930, as quoted (in English translation) in: Veit Erlmann, Reason and Resonance. A History of Modern Aurality, New York (Zone Books) 2010, 325
2 Günther Stern, Typescript *Die musikalische Situation*, State Library Vienna, 1930/31, 46; now edited by xxx Ellensohn: xxx
3 Villiers d'Isle-Adam, L'Éve future, xxx 1880/1979: 34

phonograph <...>. In the midst of the hushed silence a white-gloved man emerged from the mysterious region behind the draperies, solemnly placed a record in the gaping mouth of the machine, wound it up and vanished. Then Mme. Rappold stepped forward, and leaning one arm affectionately on the phonograph began to sing an air from "Tosca." The phonograph also began to sing "Vissi d' Arte, Vissi d'Amore" at the top of its mechanical lungs, with exactly the same accent and intonation, even stopping to take a breath in unison with the prima donna. Occasionally the singer would stop and the phonograph carried on the air alone. When the mechanical voice ended Mme. Rappold sang. The fascination for the audience lay in guessing whether Mme. Rappold or the phonograph was at work, or whether they were singing together.[4]

[A similar staging of human vocal performance *versus* apparative acoustic operativity has been commented by the *Boston Journal* in the same year: "It was actually impossible to distinguish the singer's living voice from its re-creation in the instrument"[5] - . What takes place is the chrono-Sirenism of *His master´s voice*, which is the presence-generating "illusion of being present" (Peter Wicke), even if induced by technical recording.]

Sound-automatic invariance: Baroque music machines

The alternative to phonographical recording of the actual sound signal has been the "musical", that is the literally symbolic approach. Media-archaeologically this goes back to a primary scene (*Urszene*), the moment when an ancient Greek adaptor of the Phenician alphabet explicitely made use of the letters A, E, I, O, U for the symbolic notation of vowels, in order to capture the musicality of Homer's oral poetry for tradition beyond the poet's grave.[6]

By using coded symbols to caputure not the sonic signal but its information, any musical score comes close to computer programming. Here, the algorithmic *is* the machinic, already (Turing 1936).

In the Baroque epistemology, there has been a "Cartesian" fascination with the animal as machine[7]; Robert Fludd designed a musical automaton in the absence of humans, different from Wolfgang von Kempelen's subsequent chess playing automaton which has been criticized by Walter Benjamin for having included a hidden human dwarf.

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4 "Edison Snares Soul of Music", in: New York Tribune v. 29. April 1916, 3
5 Quoted after: Emely A. Thompson, Machines, Music, and the Quest for Fidelity. Marketing the Edison Phonograph in America 1877-1925, in: The Musical Quartely Bd. 79 (1995), 132. See Peter Wicke, Das Sonische in der Musik, in: Das Sonische. Sounds zwischen Akustik und Ästhetik, in: PopScriptum 10 (2008), *online* http://www2.hu-berlin.de/fpm/popscrip/themen/pst10/index.htm
6 See Barry Powell, Homer and the Origin of the Alphabet, 2000; further W. E. / Friedrich Kittler (eds.), Die Geburt des Alphabets aus dem Geist der Poesie, Munich (Fink) 2007
7 See e. g. Salomon de Caus, *Les Raisons des forces mouvantes* (1615)

Musical automata are material reifications of musical compositions. Music from the Baroque era (Purcell, Händel, Bach) encorporates and intonates another temporality which differs from linear historicity. Boroque music, when performed in the present, generates a co-originary aesthetic presence. The reason is the mathematical, that is: *per definitionem* metahistoric algorithm of music composition, beating the time arrow by numerical operations (Newton and Leibniz' infinitesimal calculus) and therefore eqivalent to the musical automaton itself (Rainer Bayreuther).

A mechanical effort for micro-tonal inscription has been Nicola Vicentino's 1555 booklet *L'antica musica ridotta alla moderna prattica* where he proposes his "Archiorgano" which provides for 31 tone grades per Octave - an amazing, mechanically almost impossible short-cut to contemporary algorithmic realizations of micro-tonality. Research project Studio31 at Basel Academy of Music is actually (re-)building that diagram - active media archaeology.[8]

Let us decipher such a text not primarily as a document in (and for) the history of science or ideas, but rather immediately as a textual diagram of a constellation which is radically ahistorical, since it belongs to the class of subliminal sound analysis which is being performed nowadays with computer software like Skyline for the graphical presentation of "tempo" on the real time axis.

Machine music is not only technical in the material sense but rooted in the close interrelation between music & mathematics in occidental sound culture; this makes it probable that the "mathematical" enunciation can be authentically re-enacted such as Johann Sebastian Bach's "well-tempered piano"; Henry Cowell, in his *New Musical Resources* (1930), actually recommends the Player Piano for the realization of Bach's structual music.

The "Kunst der Fuge" escapes - as expressed in its very name - the temporal flow, operating rather with stationary, that is: history-invariant sequences. Therefore mechanic instruments are not historic documents but media-archaeological monuments (leaving aside its physical entropic decay).

The machine renders music to our ears just as it has been doing to the ears of listeners in by-gone days, since there is no recording medium inbetween but an immediate re-production of the musical event. Being digital *avant la lettre*, it renders itself natural to *online* re-enactment.[9]

[Sound emanating from a musical automaton is no recording of acoustic signals but "originäre Klänge eines Musikinstruments"; therefore, in contemporary so-called historic performance practice, such apparatuses are unique. While for human-instrument coupling there can only be an approximation towards the

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8 See www.projektstudio31.com
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http://www.landesmuseum.de/website/Deutsch/Sammlungsausstellungen/Auss
enstellen_und_Zweigmuseen/Deutsches_Musikautomaten-
Museum_Bruchsal/Musikautomaten-Galerie.htm (Zugriff 14. Dezember 2009)

authentic musical situation in the past, "repräsentieren die mechanischen Musikinstrumente als einzige Quelle eine authentische Wiedergabe"[10].]

A machanism for sonic time travelling: the piano roll

There is an explicit media-archaeological answer to the question "how historical - or informed - is historically-informed performance"? (Ghent seminar draft). Player piano rolls have been machinically "in-formed", physically invasive. Punching is violent, not simply a symbolic material trace like score notation. With the "inscription" of a recording medium, the paper roll; graphical notation becomes "mechanical". Human "interpretation" intervenes not by the pianist in later times but already from sound engineers at the delicate moment when the "digitizing" puncher has to micro-interpret the rather analogue (secret of) recording graph. The function of the skilled human "editors" of piano rolls (encoding) has been to produce a dynamic code.[11]

Media-archaeologically, the (secret) recording apparatus developed by Welte company for *recording* the dynamics of piano play for replay, correlates with contemporary technical devices developed for scientific *measuring* of micro-temporal piano key movements.[12]

Sonic analytics

The dynamically faithful Welte recording of piano play corresponds with microtiming in the recomposition of past performance practice. Richard Beaudoin, since 2009, composes new, notated, acoustic works based on millisecond-faithful transcriptions of recorded piano performances, applying most refined methods of acoustic microscopy and microtiming.[13] Interpretation as sonic hermeneutics and as scientific measuring the acoustic event, all of the sudden, are no contradictions any more.[14]

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10 Helmut Kowar, Mechanische Musik, Vienna (Vom Pasqualati Haus) 1996, 47
11 Reinhart 2005: 84
12 Such as the graphical registration developed by Alfred Binet and Jules Courtier, Recherches graphiques sur la musique, in: L'Année Psychologique vol. 2, Paris 1986, 201-222. See Wolfgang Auhagen, "In Search of Beauty in Music". Zur Geschichte der musikpsychologischen Interpretationsforschung, in: Loesch / Weinzierl (eds.) 2011: 15-26. For an exemplary case study, see Hermann Gottschewski, Die Interpretation als Kunstwerk. Musikalische Zeitgestaltung und ihre Analyse am Beispiel von Welte-Mignon-Klavieraufnahmen aus dem Jahre 1905, Laaber (Laaber) 1996
13 See Richard Beaudoin, The Principles of Microtiming and Musical Photorealism, manuscript http://nrs.harvard.edu/urn-3:HUL.InstRepos:3415685
14 See Heinz von Loesch / Stefan Weinzierl (Hg.), Gemessene Interpretation. Computergestützte Aufführungsanalyse im Kreuzverhör der Disziplinen, Mainz et al. (Schott) 2011

"Western musical notation has been developed to represent [...] works that require performative interpretation."[15] But a spectrogram, e. g. of the first 21 seconds of Chopin's *opus* 28/4 in Martha Argerich's 1975 interpretation, created with the Lucerne Audio Recording Analyzer (LARA)[16], may be considered a sono-analytic "photograph" of the performance: "A spectrograph represents *sounds*, or vibrations in the air, but not *music*, which requires perception of a uniquely human sort [...] just as we see three-dimensional objects *in* certain two-dimensional arrangements of pigment."[17] Baudoin then manually transferred the spectrographic information into a symbolic score (*Latticed Window*).

[For *continuous* Fourier analysis, a "perspective" diagram (suggesting three-dimensional unfolding of the signal) is applied, which provides insights for relatively harmonious spectra but not for sudden signal changes. Still, such a time diagram consist of a multitude of discrete points, like an escalation of the punched piano roll.]

[As has been expressed by Boris Yankovsky in his Syntonfilm Laboratory in Moscow, once sound has been spectrographically analyzed, it could be re-synthesized back, leading even to synthetic acoustics without human source at all like the Vo(co)der; such graphical sound extends to manipulations like time-stretching and pitch transposition.[18]]

Such is re-hermeneutizing machine analysis, just like in early ninteeth century, lithographic engraving endured as "critical" form of reproduction of historical paintings, rivalling the "new" medium of photography.[19]

A Chopin score "is not a transcription of a performance; it prescribes how certain performances [...] should be [...]. In this respect, it is more like the circuit diagram an engineer produces for a new electrical component [...]"[20] - diagramatic sonicity (as variance of Peirce's concept of "diagramatic iconicity").

Digital art preservation (which is not the musicological but the museological challenge for the tradition of contemporary media culture) knows the concept of "reinterpretation" for installations which can not be faithfully reenacted in its hard- and software and site-specific interaction. Its "historical" integrity can be approached only in discursive documentation and conversation with the original artist[21]. In contrast, a media-archeological re-interpretation aims at an operative, non-discursive, rather functional equivalent (called "emulation") of the artwork (infra-)structure, including its processual micro-timing.

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15 Baudoin / Kania: 123
16 See Beaudoin / Kania: 122, Fig. 4: output from the Luzern Audio Recording Analyzer (LARA), showing the millisecond-faithful measurement of four bars of Chopin Op. 28/4 in the recording of Martha Argerich from October 1975
17 Richard Beaudoin and Andrew Kania, A Musical Photograph?, in: The Journal of Aesthetics and Art Criticism, 115-127 (121)
18 See Smirnov 2013: 209-226
19 See Segolen leMan, xxx
20 Beaudoin / Kania: 124
21 See entry "Reinterpretation" in the glossary of Serexhe (ed.) 2013: 638

While Orpheus Institute explicitly keeps "the artist's perspective as the starting point of research" for musical knowledge, media archaeology asks for a counter-balance, closer to the methods of exact science, analyzing media-induced phenomena on the level of their actual appearance, that is: enunciations in terms of Michel Foucault's *Archéologie du savoir* (1969), There are real (in the sense of indexial) traces of past sonic articulation, different from their indirect evidence symbolically expressed in literature, historical descriptions and musical notation.

In terms of context-intensive historical understanding of culture, there are "limits of what we can know, say, or do where past musical practices are concerned" (seminar draft); in the case of technological storage, though, in mechanically fixed recording, re-activation at any later moment in time is possible, against all growing physically entropic obsolescence and historical or transcultural distance.

[There are limits to archaeological and philological reconstruction of past musical practice indeed, due to the scarcity and unreliability of ancient sources on music.[22] But unexpectedly, new tool for research on ancient *mousiké*: have arisen, enabling us to (re-)enact textually received mathematical arguments on music in the computing space, re-creating the ratios of sound and melodies by digital signal processing.[23]]

Like a musical score notated for piano, an algorithm coded for computer needs to be instanciated in order to unfold as actual sonic event.[24] The individual "interpretation" by the human pianist, though, radically differs from what the nonhuman compiler or (literally) *interpreter* does in implementing digital code. While the concept of "historically informed" performance of music from the past understands information in respect to the historical contexts[25], in the case of nonhuman piano play even the dynamics and micro-temporalities of individual interpretation from score is coded into a Welte-Mignon roll.

[Even "analog" recording, by subsequently transforming the wave forms into numerical frequency values, can then be "digitally" calculated. With the arrival of the phonograph, cultural tradition has been enriched by sonic signal memory. But only the digitizing of such signals allows for its algorithmic analysis, creating an archive (symbolic order, turned into sequentially ordered binary symbols) for future re-enactment. A/D conversion ("sampling") of musical performance therefore is *futurum exactum* already and allows for retro-analysis of the actual signal event.]

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22 See Hermann von Helmholtz, Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik, Vieweg 1913, 444
23 See Martin Carlé, Geschenke der Musen im Streit ihrer Gehörigkeit. Die antike Musiknotation als Medium und Scheideweg der abendländischen Wissenschaft, in: Sebastian Klotz (ed.), xxx
24 Innocenti 2013: 242
25 See John Butt, Playing with History. The Historical Approach to Musical Performance, Cambridge (Cambridge UP) 2002

By coded recording, the individual performance becomes "archival" information in the sense of communication engineering (Shannon). Its reproduction on a Player Piano actually *is* "informed", but not in a historical, but media-archaeological sense. The Welte-Mignon is no musical performance but a techno-musical operation (in the sense of Turing's equation of algorithm and machine).

[A player piano *alias* "Pianola", by definition, is a self-playing automaton; a pneumatic or electro-mechanical "mechanism that operates the piano action via pre-programmed music recorded on perforated paper, or in rare instances, metallic rolls, with more modern implementations using MIDI encoded music stored on floppy disks or CDs"[26]]

[Larry Givens, Re-Enacting the Artist. A story of the Ampico reproducing piano, 1970]

[Composer Beaudoin created a collection of works for solo cello, based, among others, on microtimings of Debussy's Welte-Mignon roll (called "Bacchante"); borrowing the book title *Digital Memory and the Archive* for one of his works. In the context of such cello music, the phrase "digital archive" includes the double meaning of digital, as relating to the fingers. Here the human-machine interface becomes decisive: the keyboard for discrete input.]

[Traditional musical notation for piano has been a "loose coupling" of discrete values which becomes a "tight form" (literally in-formed) only in the moment of individual interpretation by the performing pianist. While the composer (the "information source" in terms of communication engineering) has transduced his musical message by coding as score for "sending" it through the material channel of (cultural) transmission, beyond the technical "receiver" (decoding the score), the "information well" [*Nachrichtensenke*] is still a human interpreter again.[27] In a more precise theory of communication (Shannon), the receiver is, first of all, a technical device which finally renders the message to the human ears. If the coupling of punched paper roll and Player Piano becomes the "interpreter" (which in Charles S. Peirce's and Frider Nake's sense can be nonhuman like computational software), ambiguities are radically removed. From "allographic" (in Nelson Goodman's terms) musical composition, the machinic recording becomes "autographic".[28]]

Chrono-vibrational resonance: Experiencing the (Mono)chord

Media-temporality is experienced by experimenting with the physical media themselves and thus the re-enactment of the experiments conducted by

26 https://en.wikipedia.org/wiki/Player_piano, accessed 19th january, 2017
27 See Perla Innocenti, Keeping the Bits Alive: Authentizität und Langlebigkeit für digitale Kunst, in: Bernhard Serexhe (ed.), Konservierung Digitaler Kunst / Digital Art Conservation: Preservation of Digital Art. Theory and Practice, Cologne (ZKM) 2013, 232-247 (243)
28 Innocenti 2013: 242, referring to Nelson Goodman, Languages of Art, Oxford / London (Oxford UP) 1969

Pythagoras, when pulling the string on the monochord, enables us to experience the "musical", i. e.: from "a temporal" to an "atempoal" relationship between integer numbers and harmonic musical intervals. "La musique, elle, est fondamentalement art du temps. Comment alors réussir à lui conférer une transcendance intemporelle?"[29] Like historiography, music (as conceptual / notational event) is only symbolical (in fact: spatial) order of "time"; temporality comes in only with the linear (analog) or sequential (digital) machine.

Even if we are not in the same "historical" situation as a Pythagorean ancient Greek, and our mode of listening must be considered to be very different, then the monochord is still as a time machine, inviting to share, participate at the original discovery of musicological knowledge. This approach of re-enactment, close to the practice of experimental (pre-historic and classical) archaeology, gives access to the invariants of knowledge in time; the physical objects themselves record time, and function as technological time capsules or time machines, different from historicizing. René Munnik: "Entering a time machine implies isolating an item from its context. Consequently, particulars can be made persistent, but not their total context or 'world'. It is the strength of the hermeneutical approach that is emphasizes the historicity of the world [...]."[30]

[Resonance is a form of instanteneous communication and "allows things to respond to each other in a nonlinear fashion."[31] It is technologically well known within the electro-magnetic field (such as the communication between radio sender and radio receiver), extends to the techno-temporal relation between presence and past as well, which thereby ceases to be a historiographically linear one.[32] „Being tuned" (Heidegger) in the present leads to a different kind of communication with the past as *implicit sonic* resonance.[33]]

But in media time (like "music" as defined by Günther Anders), the artefact emancipates from human-made "historical" context (as defined by Giambattista Vico); technology is rather rooted in a different "world": technical and logical nfrastructures. Such a redefinition of "context" allows for a new form of access to past music performance: techno-hermeneutic, e. g. the

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29 J. J. Nattiez, Gould singuliers: structure et atomporalité dans la pensee gouldienne, in: G. Guertin (ed.), Glenn Gould Pluriel, Quebec (Louise Courtau) 1988, 61

30 René Munnik, Technology and the End of History. From Time Capsules to Time Machines, in: Liisa Janssen (ed.), The Art of Ethics in the Information Society, Amsterdam (Amsterdam UP) 2016, 106-109 (109, note 4, referring to: Heidegger, Sein und Zeit 2006: 372-404 (German orig. 1927, esp. passage "Altertümer im Museum"); see further Martin Heidegger, Ursprung des Kunstwerks (1936), and Hans-Georg Gadamer, Wahrheit und Methode, xxxHeidegger

31 Erik Davis, Acoustic Space, Riga 1997 = http://www.techgnosis.com/acoustic.html (xxx)

32 See Rupert Sheldrake, The Presence of the Past, xxx

33 On Heidegger's notion of „Gestimmtheit", see Erlmann 2010: 327, and Heidegger's lecture on logics (Logik-Vorlesung) 1934, 129 and 135

"physical modelling" of conventional music instruments, and the "audification" of past concert halls by computational modelling).

[Media-actively, this corredponds with technologies of "auralisation" as the retro-mesauring and emulating (mapping) of room acoustics in former concert halls (Stefan Weinzierl) - archaeonautics of sound.]

Audio-technically induced (transduced) "archiving" of deferred presence

Different from emphatic cultural *memory*, techno(archeo)logy deals with intermediary storage.

In phonography, just the actual sound (the "pheno-text", with Kristeva) is continually recorded by the revolving storage medium, while the "digitally" punched roll in the Welte-Mignon player piano since 1904 automatically replays the geno-text as well: "the tempo, phrasing, dynamics and pedalling of a particular performance, and [...] the notes of the music, as was the case with other player pianos of the time"[34] - from recording to recoding. This recoding, once implemented on a mechanical instrument, allows for the co-original reproduction of the sound event - just like in current synthesizer technology (as could be noticed at the Super Booth fair in Berlin, April 2017) some beats result from a coupling of the electronic device triggering actual physical drums again instead of mere loudspeaker membrane rhythm. The Welte apparatus has been "post-digital" *avant la lettre*, interlacing both signal-sensitive (time / touch / dynamics) analog and digital (coded) sound recording.

[The contingent temporalisations of a muscial score by actual interpretation differ from the equi-distant clocking in electronic and digital audio-processing; the machine takes over the agency of micro-timing. "Hearing music, we oscillate with its metric wave."[35] Is there temporal in-formation by such pulsating sound? And is this metamorphosis algo-rithmically achieved?]

Genuine techno-musical recording allows for equiprimoridal reperformance, as has been defined for "acousmatic", that is: loudspeaker music' which "can be said to encompass all fixed media (in old parlance "tape") music, without live performers or other media, regardless of whether it is based on recorded or synthetic sounds"[36]. The electro-acoustic engineering gesture of "rewind" in reel-to-reel magnetic recording actually challenges the notion of temporal irreversibility for historic music performance, as (almost allegorically) expressed in Samuel Beckett's one-act drama *Krapp's Last Tape* (1959) where

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34 https://en.wikipedia.org/wiki/Welte-Mignon, accessed 19 January 2017
35 Victor Zuckerkandl, Sound and Symbol. Music and the External World, Princeton (Princeton U. P.) 1956, 204 f.
36 Nick Collins, Margaret Schedel, and Scott Wilson, Electronic Music (Cambridge: Cambridge University Press, 2013), 125

the main actor gets lost in the memory loops of his autobiographic tape recordings.[37]

["Historical ecologies", drawing on Bruno Latour's ANT, may be described as "a web of relations, an amalgamation of organic and inorganic, or biological and technological, elements that are interconnecting and mutually affecting"[38]]

Steve Reich's composition *Violin Phase* grew out of his realization of the human capacity for, as he wrote, "imitating machines". "While in his writings the word 'machines' sometimes evokes the broader category of any mechanical devices with repetitive motion, the tape machine is often the specific referent. Reich describes overcoming his initial fears that humans would be incapable of the gradual phase shifting process by discovering in 1966 that he could play along with a tape loop 'exactly as I were a second tape recorder'."[39]

The human piano informer of historical music is an individual "subject" as interpretative agency but "subject" to code, and becomes coupled inbetween symbol reading (score) and mechanical keys (Karsakov 1932), in a turingmachine like state, partly machinic.

[How close can a listener with Welte-Mignon come to original intentions of a past piano player - who had consciously devoted himself to the mechano-phonographic recording. Each individual roll, depending on the thickness of paper, for re-play, necessary requires the re-adjustment of tempo (speed) in the pneumatic motor. The micro-temporal authenticity will stay fuzzy until an original recording apparatus will be re-discovered, for uncovering the techno-logics ofthe machine and thereby judge the recording with rather mechanic than hermeneutic certainty.]

[There is the piano keyboard in the field of discrete, coded music (and symbolically coded archival records), different from phonographic recording which can be re-played as signal.]

The notion of "historically *informed*" performance, in a precise sense of "information", is a function of the archive, that is: the symbolic code, be it alphabetic texts, musical scores, or now: numerical data values.

Phono-graphical analysis vs. hermeneutic interpretation

The media-archaeological perspective on "historically informed performance" focuses on the operative interpretation by the machine itself. The muscial

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37 See further the editorial of the "tape issue" of Twentieth Century Music (2017), eds. Bohlmann / McMurray)
38 Benjamin Piekut, 'Actor-Network in Music History: Clarifications and Critiques', Twentieth Century Music 11/2 (2014), 212
39 Joseph Auner, Reich on Tape: The Performance of Violin Phase, in: Twentieth-Century Music 14/1 (2017), 77–92 (80), referring to: Steve Reich, Writings on Music, 1965–2000, ed. Paul Hillier (Oxford: Oxford University Press, 2002), 24 and 22

machine, in terms of Actor Network Theory, is a "nonhuman agency", it co-interprets.

Rather than simple repetition of phonographic signal recording, the Welte-Mignon mechanism is about equi-primoridal re-production (*mimesis*), different from Walter Benjamin's critique of *Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit* 1936/37. George Antheil arranged Part I of his Ballet Mécanique for Welte-Mignon piano.

There is a whole culture of music automata, but the truly media-archaeological object of interest in the Melte-Mignon case is not the discrete player piano mechanism itself but its pre-condition: the analog recording mechanism which has been concealed and significantly disappeared.

The analysis of the player piano therefore starts with its techiques of recording. Mechanic and electronic recording devices catch acoustic signals more precisely than any symbolic score notation does. Just like the Edison phonograph in 1877 enabled not only speech reproduction but, in reverse, analytic access to the physically real audio event, the difference in piano play recording as well is between musical notation of piece for piano and actual sonic signal recording of piano playing with its unique "temp*aural*" individuality (to modify Benjamin); pressure and tempo in piano play, seen from techno-physical perspective, are time signals.

[The micro-temporal analysis as actual interpretation of a score by the piano performer has replaced the "philological" interpretation of the written score as *oeuvre* in Western music.]

This corresponds with the machine recording of piano play itself. The mechanism of the Welte recording for player piano has been kept secret by the company and mostly hidden to the actual performer, dissimulated in favor of the appearance of a traditional piano. Therefore it takes the most precise efforts of media archaeology to reveal the secret.[40] The piano as instrument, like the cembalo, had been a mechanism already, known to the performer, but a media act of a second order takes place with automatic recording. As with most technical muscial instruments, the interface hides the mechanism.

[From the evidence of a few surviving yet un-punched Welte piano rolls (for "correction"), it can media-forensically be concluded that the recording apparatus created proportional electro-chemical inscriptions of the dynamics of touch and tone from electro-mechanical contacts within a mercury tank; the ink graph was inscribed by rubber wheels on 100 tracks, induced by electric circuits, and then manually "transcribed" (actually "coded" in the sense of Hollerith machines) by human punchers into rolls. What still remains is time-critical incertitude, caused by the paper thickness and cylinder speed.]

Only one recording apparatus for the parallel mechanism of the Welte-Philharmonic-Organ has survived (from the former recording studio of Welte company in New York), finally on display in the Swiss National Museum for Musical Automata at Seewen:

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40 Reinhart 2005: 79

[Nikolay Bernstein's "chronocyclography" has been a parallel efforts for techno-analytically catching the musical "gesture".[41] Graphical analysis results in a spatialization of the sonic time axis; a geometrization of the sonic event, disenabling it of its essential message which is time, ultimately re-Pythagorizing the musical event into a mathematical ratio instead of its processual wave event.[42] But when coupled to a machine reading, graphical inscription becomes a musical time-event again.[43]]

A punched piano roll, though readable for eyes which got used to its punctuations, has never been "written" for human eyes, but for mechanical decoding - like the binary digits within a Turing machine for the read/write "head" (Turing 1936/37).

Recording technologies provided for a new criterium of artistic practice which is its micro-temporal aesthetics. Such information on the actual dynamics and minute tempo differences needs actual machine performance to become evident. Current motion-capturing of piano play for neuro-aesthetic analysis (Godoy) in fact provides the data for future "historically informed" re-performance; with the unbiquitous digital recording of musical action, the musical culture of the present already becomes a pre-emtive *futurum exactum*.

[One of the first audio-visual recordings in ethno-musicology is the sound "movie" of *guslar* Avdo Medjedovic's variance of oral poetry in the Milman Parry Archive of Oral Literature at Harvard University. Epical orality, fixed on phonographic media like the master recording of a Jazz improvisations, have almost immediately been transcribed for philological interpretation by the scholars (Milmar Parry, Albert Lord) and transcribed into a score for musical research by Bela Bartok in its time. By its parallel storage on aluminium disc, wire spool or sound film as signal memory, though, it can now be techno-mathematically be "transcribed" into a score of a different kind, serving "Digital" (or better: algorithmicized) Humanities research. A different kind of "transscription" of piano play dynamics not into a musical, but a "machine language" (almost Assembly-like) score, has been enacted by the human punchers in the Welte roll factories. While sound film recording remains external to the instrument-player (machine-body) system, the photo-electric generation of sound from light waves from within an instrument (such as the Welte organ) is truly media music.[44]]

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41 See Julia Kursell, Moscow Eye and Ear-Control. Über die neurophysiologischen Arbeiten von Nikolaj Bernsteijn zum Klavierspiel, in: Sabine Flach / Margarete Vöhringer (eds.), Ultravision. Zum Wissenschaftsverständnis der Agantgarde, Munich (Fink) 2010, 83-105
42 Hermann Gottschewski, Graphic Analysis of Recorded Interpretation, in: Computing in Musicology vol. 8, 1992, 93-96
43 See Binet / Courtier, Recherches graphiques sur la musique, in: Scientific American 22 (Febraury 1896), 16801-16802, supplement no. 1051; previously published in: *Revue Scientifique*
44 On the opto-acoustic ("optophonic") discs in Welte organs, see Peter Donhauser, Elektrische Klangmaschinen, Vienna - Cologne - Weimar (Böhlau) 2007

It has been the ambition of the Welte-Mignon automatic piano play recording to reproduce the actual individual performance of the interpreter of a score; the machine itself is the "interpretant" in Peirce's sense of *semiosis* (just like algorithms in computing, according to Frider Nake).

Discrete coding differs from graphical notation just like the difference between material reproduction (embodiment of the piano mechanism) and phonographical replay. The Welte-Mignon recording/replay mechanism as analog/digital hybrid allowed to capture both conditions necessary for techno-logical reproduction of an original musical piano player performance, as expressed in a booklet for use of american Welte-Mignon recording mechanism, published 1917.

["Mit diesem wunderbaren Wiedergabegerät ausgestattet [...], [...> wird die ursprüngliche Interpretation reproduziert, oder neu erschaffen, mit allen feinsten tonalen Schattierungen, Akzenten und Eigenheiten des Ausdrucks."[45]]

Fig.: Reinhart 2005: 82, advertising on coding the roll, from Welte-Licensee catalogue 1924: section from an original recording of Chopin's Etude in F Major

"Every detail of the artist's playing is graphically recorded while he plays. With this absolutely authentic 'tone picture' [...] the record is not a mere approximation, but an exact reproduction of his playing. What may be called the 'film of the music camera' receives impressions of every detail of both his fingering and pedaling. The exact position of every note played is fixed by faint vertical lines corresponding in number to the keys on the piano" - like phonographic groove. "The staggered lines [...] are the means by which the mechanism, like the delicate needle of the sismograph that recordes the slightest tremor of the earth, graphically indicates exactly the degree of pressure with which the artist struck the keys, thus faithfully recording the finest shading of his interpretation."

Human senses can not cognitively integrate the machine its sees with what is hears: Lubka Kolessa, in 1928, plays Frédéric Chopin on Welte-Mignon: Mazurka No. 23 D-Dur Op. 33, 2

This leads to an increasing techno-trauma. Technical re-enactment instead of simply replaying the authentic performative momentum, miracolously under the conditions of digital media, is: the most in-human mechanism, resulting in an epistemological irritation of cultural semantics: the "original copy" (an oxymoronic term from contemporary copyright legislation).

Music score publisher White-Smith raised a copyright law issue against player piano roll producer Apollo for issuing two of their works; the U.S. Supreme Court in 1908 though defined such rolls as integral part of the mechanism and therefore no copies of the artwork: "Even those skilled in the making of these rolls are unable to read them as musical compositions, as those in staff notations are read by the performer."[46]

45 Mark Reinhart, Der Welte-Mignon Aufnahmevorgang in Deutschland, in: Dangel (Red.) 2005: 74-87 (79)
46 As quoted in Samuels 2000

In times of post-hermeneutic theory, the score is not the exclusive subject of musicological research any more; as well the real embodiment matters (both in terms of physical sound and the psycho-physical performer), its presence and event. Friedrich Nietzsche once defined aesthetics as "applied physiology". Today, this extends to applied cybernetics. With the machine capturing of past human "musical" physiology and cognition from analog to digital, not only scientific analysis, but technical re-synthesis is possible. Musical culture must first become completely inhuman by another cultural knowledge operation (the machine) in order to be unfolded again.