["TEXTS AND NOTES ON ELECTRONIC VOICING AND TECHNICAL SONO-POIESIS"]

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I ELECTRONIC VOICING AND TECHNICAL SONO-POIESIS (nearly edited):

THE PHONIC CHOQUE

The phonographic Nipper effect: "shocking" logocentrism

In their incubation phase, new technologies get media-archaeological (instead of mass-media) attendance. "When a new technology comes into being and is diffusing"[1], it is usually subject to a closer description than retrospective discurse analysis alone would yield. Marcel Proust describes the experience of his grandmother's telephone voice at a time when this electro-acoustic device was still not yet digested into everyday practice and rather perceived as a spectral "medium".[2]

[1] Hayles 1999: 207

[2] Marcel Proust, Auf der Suche nach der verlorenen Zeit [Marcel Proust, Frankfurter Ausgabe,

"The voice, separated from its body, evokes the voice of the dead"[3], as exemplified by the narrator in volume three (*The Guermantes Ways*) of Marcel Proust's *In Search of Lost Time* for the case of a telephone talk with the distant grandmother. The affective-cognitive dissonance of experienced nearness in spite of the knowledge of distance results in a gap similar to the affective listening of a musical recording from the past: "A real presence, perhaps, that voice that seemed so near - in actual separation!" <Proust 2001: 419>.

This gap is structurally akin to the central feature of trauma: a non-historicisable affect of presence. The way Proust seeks to describe the psychic schock induced by the phonographic voice reveals a special aspect of the overall novel theme of *la recherche du temps perdu*: It is impossible to integrate this temporal experience into narrative discourse; one can not symbolically representat real signals, "an instant that resists transmutation into discourse"[4]. What can be scientifically described, though, is the micro-eventality of signal transduction from phonographic record and its physiological processing in the human ear, the almost transient identification of the individual speech timbre and its micro-temporal creation of awareness ("presence") in human consciousness.

With the Edison phonograph, the auratic uniqueness of the ephemeral voice has been replaced by its very iterability - deferred logocentrism (in Derrida's sense). This shock has not yet been digested in the cultural unconscious.

While for HiFi-trained listening today, in early phonographic music recording, the signal can hardly be discreminated from the noise of the rotating cylinder, on the other hand, in 1916, an experimental performance in New York's Carnegie Hall directly compared the living singer's voice to her phonographic recording: "Alone on the vast stage there stood a mahagony phonograph <...>. In the midst of the hushed silence a white-gloved man emerged from the mysterious region behind the draperies, solemly 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."[5]

On occasion of an analogous confrontation between vocal human performance and phonographic technical operativity, in the same year the Boston Journal reports: "It was actually impossible to distinguish the singer's living voice from its re-creation in the

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ed. Luzius Keller, Werke II], vol. 3: Guermantes, Frankfurt/M. (Suhrkamp) 199 6, 186. See as well the chapter on "hauntology", in: Simon Reynolds, Retromania. Pop Culture's Addiction to its own Past, London (Faber & Faber) 2012

[3] Dolar 2006: 64

[4] Paul Frosh / Amit Pinchevski, Introduction, to: same authors (eds.) 2009: 1-22 (8)

[5] "Edison Snares Soul of Music", in: New York Tribune, 29th April, 1916, 3

instrument."[6]

With the phonograph, all of the sudden, the ephemerality of the human voice and musical sound became disposable in a way Henri Bergson criticized for the phonographic illusion of technically capturing movement. Life, as it were, became artifical. Until phonographic recording, the performance of insubstantial musical works had been experienced as akin to the transience of
living beings:

"But ever since Edison heard his phonograph singing 'Mary had a little Lamb' in December 1877, he destabilized this metaphor, challenging the uniqueness of any single duration. [...] By fixing a reality, hitherto subject only to direct experience, Edison's invention also apparently fixed the unfolding of time. [...] Sound could now be captured, commodified, and replayed; the passing of time, therefore, could be objectified, recalled, and re-lived; our existence - allied to that of time - could, with the aid of technology, be re-presented indefinitely. Our presence could thus quite literally be re-membered. If families do indeed listen to their deceased relatives, as Edison suggested, they - like Nipper - feel an eternalized presence; this, however, is nothing but the specter of one's remembrance, the flipside of which is that listeners experience the presence of their own mortality: an apparition inscribed as grooves onto a metallic tomb. "[7]

Acoustic signals, once recordable and thus replayable, transformed from an immediate sonic experience ("musical presence") to technically implicit "sonicity".

As has been iconized by the HMV record label *logo* (derived from Barraud's original painting), the dog Nipper literally listens to "His Master's Voice" on his very coffin.[8] The real stays with the corpse (Lacan). For Adorno Nipper in this painting is "the right emblem for the primordial affect which the gramophone stimulated and which perhaps even gave rise to the gramophone in the first place. What the gramophone listener actually wants to hear is himself, and the artist merely offers hm a substitute for the osn diage of his own person, which he would like to safeguard as a possession. <...> Most of the time records are virtual photographs of their owner <...> - ideologies."[9]

The priordial affect of listening to absent voices from phonograph stems from the technological impetus itself. Adorno here folds the two components of the Narcissus theorem into one: the "acoustic mirror" (failing to recognize the audio-visual rupture inbeteween). But in fact Adorno

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[6] As quoted in: Emely A. Thompson, Machines, Music, and the Quest for Fidelity. Marketing the Edison Phonograph in America 1877-1925, in: The Musical Quartely vol. 79 (1995), 132. See Peter Wicke, Das Sonische in der Musik, in: PopScriptum 10 (2008), *online* http://www2.hu-berlin.de/fpm/popscrip/themen/pst10/index.htm

[7] David Trippett, Composing Time. Zeno's Arrow, Hindemith's *Erinnerung*, and Satie's *Instantanéism*, in: Journal of Musicology 24 (2007), 522-580 (538)

[8] See as well "Prayers of a Phonographic Doll", online: http://forums.ssrc.org/ndsp/2014/01/29/prayers-of-a-phonographic-doll (accessed August 2014)

[9] Theodor W. Adorno, as quoted in the extracts from Sterne 2003 in: Smith (ed.) 2004: 306

locates the driving "traumatic" force in the technical invention which led to the phonograph in the im/moretality impulse - just like Sterne's subtitle to *The Audible Past* reads: "Cultural Origins of Sound Reproduction". Only with such sound reproduction becomes the past audible in the sense of a "historic" record (literally). But media-archaeological close inspection reveals that is was phonetic research (Léon-Scott) which led to the Phon(auto)graph. There is an autonomous inner-technical logic(s) which leads to the apparatus; its powerful impact in fact derives from the coupling to a discours (the obsession with im/mortality in the Victorian age). "The inside of sound was transformed so that it might continue to perform a cultural function"[10], namely the desire for immortablity. But this confuses the scientific interest in phonography with a cultural discourse.

While historiography refers to times past which are by definition absent, audio-visual signal recording in fact creates repeatable presence. While symbolical historiography semiotically refers to an external temporal referent, signal recording keeps presence in latency which is a different category of technical and psychic time. While the status of the witness in terms of historical research is clear, media audiences are not simply recipients of someone else's testimony[11] but by the very electro-magnetic nature of live transmission (and its recording) actually become witnesses in repeatable event space. The non-decidability for human spectators between "live" and recorded sound & image leads to a kind of temporal Turing test (not of "intelligence", but of the "time sense"): Recorded past or actual present? This is not derived from a traumatic experience, but leads to a traumatic irritation of the human sense and metaphysics of "presence".

The role of the IBM computer in the *Jeopardy* quiz and in the film *Desk Set* reminds of the classic "Turing test" (now famous from the movie *The Imitation Game*). Traumatic affects or schocks induced by technology itself differ from trauma studies which are related to historical events. The human/machine difference worked well as long as Descartes could separate body-automata from the soul, but got more irritating when it came to experiments in artificial intelligence.

Audio recording on magnetic tape allows on the signal level what Turing designed for symbolic operations on paper: "Like the phonograph, audiotape was a technology of inscription, but with the crucial difference that it permitted erasure and rewriting."[12] In 1962 William Burroughs published *The Ticket That Exploded* describing visionary technologies inspired by magnetic recording.[13] "[I]t was a startling discovery to learn that one's voice could be taken out of the body and put into a machine, where it could be manipulated to say something that the speaker

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[10] Sterne 2003, as reproduced in Smith (ed.) 2004: 306

[11] See Paul Frosh, Telling Presences. Witnessing, Mass Media, and the Imagined Lives of Stangers, in: Frosh / Pinchevski (eds.) 2009: 49-72

[12] N. Katherine Hayles, How We Became Posthuman. Virtual Bodies in Cybernetics, Literature, And Informatics, Chicago / London (University of Chicago Press) 1999, 209

[13] William Burroughs, The Ticket That Exploded, New York (Grove Press) 1967, chapters 9 and 10; see as well same author, Electronic Revolution, Bonn (Expanded Media Editions) 1970

had never heard before."[14] As assumed by Arnold Gehlen[15], this is exactly what defines the human different from other animals that he/she is orignary lacking completion, that is: always already coupled to symbolic or other forms of supplementation, therefore: always already non-human as well.

The vocal apparatus actually produces subvocalization during silent reading - the implicit phonograph.[16] This subvocalization is not only essential to the production of literary language but is a reverse engineering of the origin of the phonetic alphabet itself which introduced discrete vowel letters for recording the musicality of Homer's oral poetry.[17]

Poulsen's patent description of the Telegraphone[18] points out that signal recording differs from alphabetic writing in being a different, non-symbolic inscription: graphical sound. Once vocal sound is no longer symbolically situated in the vowel characters of the alphabet but as signals in the machine, it can no longer be represented within the world of the text. The technological qualities of audiotape that changed the relation of voice and body: "Telephone and radio broke the link between presence and voice by making it possible to transport voice over distance"[19] - a perceptual shock disrupting occidental logocentrism.

As long as archival records consist of coded symbols in alphabetic writing, a cognitive distance - in spite of the auratic qualities of handwritten manuscripts or autographs - can be more or less kept, since an act of decoding has to take place which involves the cognitive apparatus. But once photography and phonography, the first apparative media in its modern sense, became subject of the archive, the sense-affective, presence-generating power[20] of signal-based media cuts short the distance which is a prerequisite for *historical* analysis, in favor of mnemonic immediacy - the electric shock.

"Presence" generation nowadays oscillates between the analog and the digital, between "live" transmission and "real-time" processing.

"One can no longer distinguish, visually or aurally, between that which is reproduced and its reproduction [...] not even discern *that* or *when* reproduction or repetition, in the manifest sense of recording or replaying, is taking place. We must be informed whether or not what we

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[14] Hayles 1999: 207

[15] Arnold Gehlen, Die Seele im technischen Zeitalter. Sozialpsychologische Probleme in der industriellen Gesellschaft, Reinbek b. Hamburg 1957, esp. 7 f.

[16] See Garret Stewart, Reading Voices: Literature and the Phonotext. Berkeley (Univ. of California Press) 1990, as referred to in Hayles 1999, 207

[17] See W. E. / Friedrich Kittler (eds.), Der Ursprung des Vokalalphabets aus dem Geist der Poesie, München (Fink) 2007

[18] Valdemar Poulsen, Method of Recording and Reproducing Sounds of Signals, reprinted in: Marvin Camras, Magnetic Tape Recording, New York (Van Nostrand Reinhold Company) 1985, 11-17

[19] Hayles 1999: 208

[20] See Hans Ulrich Gumbrecht, Production of Presence. What Meaning Cannot Convey, Stanford University Press 2004

are seeing is "live". <...> we cannot distinguish through our senses alone between what we take to be simply "alive" and what as reproduction, separted from its origin, is structurally posthumous [...]."[21] This chrono-traumatic irritation results in a cognitive-affective dissonance between what is conceived as "historical" and perceived as "present" indeed. What Derrida's *Grammatology* once coined the irreducible "iterability" of the mark has become electronic storage and re-play.

When audio-signals from the present are exposed to recording devices intended for future re-use, they have lost their uniqueness already in favor of archival addressability. The "life-logging" audio cassettes of the electronics avantgardist Erkki Kurenniemi, recorded during the 1970s, were intended for algorithmic re-calculation in 2048. In the (mostly pornographic) activities performed for, and recorded in Kurenniemi's video diaries, "[t]emporality is similarly split between the present tense and the future tense of a replay. The present is always folding into the future, the revisited and the re-edited."[22]

Sonic shock: Telephone call and answering machine

With Valemar Poulsen's presentation of the wire recorder at the Paris World Exhibition 1900, the telephone line which functioned as the (subjectively experienced) immediate transmission of telegraphic and tele-phonic communication turned out to be a storage medium for delayed re-play. From that resulted an irritation in the trust of presence in electric tele-communication.

Confronted with the telephone, Benjamin felt unsheltered in being exposed to the voice.[23]

The immediacy of the telephone voice can not be equalled by image-based telephony, as became apparent with the *Picturephone* propagated by Bell System in the 1960s and earlier experiments with cable-based *Bildtelephonie* in 1930s Germany[24] until the failure of Panasonic V*ideophone* (experimentally used for the Van Gogh-TV Kassel Documenta installation *virtural plaza*).

"Could there be a fundamental barrier to the acceptability of telephones with moving pictures?"[25]

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[21] Samuel M. Weber, Mass Mediauras: Essays on Art, Technics and Media, Publications of the Power Institute, Sydney, Stanford UP 1996, 121

[22] Susanna Paasonen, Slimy Traces: Memory, Technology and the Archive, in: Erkki Kurenniemi. A Man from the Future, published by the Finnish National Gallery Central Art Archives, edited by Maritta Mellais, Helsinki 2013

[23] Walter Benjamin, Berliner Kindheit um Neunzehnhundert, in: same author, Gesammelte Schriften, vol. IV, ed. Tillman Rexroth, Frankfurt/M. 1972, 235-304 (243)

[24] See Isabell Otto, Happy Birthday from Skype. Zur Darstellung von Temporalität in einer Online-Werbekampagne, in: Zeitschrift für Medienwissenschaft vol. 9, no. 2 / 2013, 53-65 (59 f.)

[25] A. V. Lewis / G. Cosier, Wither Video? Pictorial Culture and telepresence, in: Graham Walker / Phil Sheppard (ed.), Telepresence, Boston et al. (Springer Science * Business Media) 1999, 99-141 (101)

Analog telephony *is* indecical, an acoustic touch, "audio-tactile" in McLuhan's sense, since such electro-acoustic transduction keeps the integrity of the physical signal even in "transformation" of mechaincal into electric waves - while the electronic image reproduces light waves which are immaterial electro-magnetic waves itself.

Even techonologically reproduces voices from microphone / speaker "are or appear - against the dominant positions in theories of voice, media and tehatre - by no means disembodied"[26]. Technically inbetween sound and sonicity, the "disembodied" radio voice is an interlacing of both physical voice transduction and immaterial electromagnetic ("wireless") transmission. Technical signal transmission here becomes a semiotic act: "A signal is an utterance of a discursive symbol or sign, deliberately placed by the utterer within what he believes to be the field of sensuous attention of another person [...]."[27] Still, the ear as such is "unsheltered against sonic violence.[28] Violent noise - sonicistic disturbance - is even the condition for the generation of oscillations which therefore can never be completely harmonic: An external disruption has to start the periodic event ("transients" as micro-traumatic eventality which is subliminally perceived by the ear nevertheless).

"The CD player was the first medium with which most people made first personal experience with the new concept of the 'digital' in everyday."[29]

"Warm" sound from analog sound recording media in contrast to the "cold" sound from digital carriers? The difference is between "signalling presence" (analog phonography, signal-based) *versus* "archiving presence" (sampled audio signals, requiring algorithmic processing before transduced back into the analog speaker).

In the opera *Einstein on the Beach*, composed and orchestrated by Philip Glass / Robert Wilson / Lucinda Childs, a choir sings numbers and solfege syllables. Einstein's voice here is not simply phonographically disembodied, but digitally transformed into acoustic clusters.[30]

Delayed phonocentrism

Different from the phenomenological description of the voice from tape in its effects on (and media-induced irritations) of human "inner time consciousness"[31], media archaeology

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[26] Doris Kolesch, Touched by Voice, lecture at the conference *Resonances* (MPI Bildungsforschung, Berlin, November 2013), *abstract*

[27] C. J. Ducasse, Symbols, Signs and Signals, in: The Journal of Symbolic Logic, Bd. 4 (1939), 44

[28] Jacques Lacan, Die vier Grundbegriffe der Psychoanalyse, Olten 1978, 178

[29] Axel Volmar, lecture: "Enjoying CD Without Guilt: Negotiating 'Digital Sound' in High-End Audio Culture, 1982-1986", conference *Resonances. Music, Affect, and the City*, Max-Planck-Institut für Bildungsforschung (in cooperation with the Sawyer Seminar, Harvard University), 7 / 8 November, 2013

[30] As discussed by Zeynep Bulut (King's College, London), lecture: Anonymous Voice, Sound, and Indifference, at conference *Resonances* (2013)

[31] See Edmund Husserl, On the phenomenology of the conciousness of internal time (1893-

approaches the event from within the technical media drama itself. Elvis Presley's "slapback" voice, resulting from the usage of two Ampex tape recorders in the Sam Philips' Sun Record studios, is a condensed version of Krapp's voice recording in KLT, a micro-"remembering" resulting from tape delay echo within the 100 millisecond interval.[32]

Presley as well as his gitarist Moore and bassist Black "*first* found their voice in the Sun Studio"[33]. Alvin Lucier's tape-based media installation *I'm sitting in a room* (19xx) which consistes of echo-delayed re-recording of a sentence has been a seminal moment in site-specific and time-based media art. In popular music, Elvis Presley's pop-musical voice actually "did not exist until it was recorded. Dealing with the echo, Presley developed a vocal style which had the function of exposing the echo."[34] And "it is *in* the voice. As a consequence a dualism of an intrinsic sound and an extrinsic effect is undermined here"[35] - "a special organization of time" from within the magnetophone.[36] Techno-chronopoetically, "the reproduced and delayed signal can be directed via the mixer to the other tape recorder [...], where only the recording head is activated. At the mixer, the slightly delayed signal is mixed with the other signal of the other microphone. This means nothing else than that the band is recorded not only once but twice by the second tape recorder [...]. [...] Sonically this time lag becomes perceivable as a kind of echo on the voice"[37].

Case Kurenniemi

A media-specific kind of memory emerges when an individual becomes signal memory in electro-acoustic storage devices. From 1972 to 1974, Finnish artist-engineer Erkki Kurenniemi recorded private everyday entries on cassette tapes, just like in Beckett's one act drama *Krapp's Last Tape* the protagonist keeps a phonetic diary on magnetophone. From the early 1980s onwards Kurenniemi also kept a video and photograph log of his surroundings and personal events, "with the aim of producing material for a digital sampling of his life which, some time after his death, would algorithmically be revived.

1917), transl. John Barnett Brough, xxx

[32] See Tilman Baumgärtel, Schleifen. Geschichte und Ästhetik des Loops, Berlin (Kulturverlag Kadmos) 2015, 122

[33] Peter Doyle, Echo & Reverb. Fabricating Space in Popular Music Recording 1900-1960, Middletown 2005, 183

[34] Jens Gerrit Papenburg, Transatlantic Echoes. Elvis Presley’s Voice as a Product of German Magnetic Tape Machines and its Function in Americanisation of Postwar Germany. Skript version of a lecture at conference *Cultures of Recording*, April 10, 2008, Centre for the History and Analysis of Recorded Music, Royal Holloway, University of London, Egham, referrring to: Peter Doyle 2005: 184

[35] Papenburg op. cit., referring to Théberge 1997: 210

[36] Papenburg, op. cit., referring to Manuel DeLanda's description of such temporal effects and affects. See DeLanda, *Intensive Science and Virtual Philosophy* London & New York (Continuum) 2002, 72 f. and 111 f.

[37] Papenburg op. cit.

Different from Goethe or Krapp's ledger (registry), Kurenniemi did not yet pre-structure it as an archive to "govern" his future memory in anticipatory ways as archival future-in-the-past. How to cope with such an abundant mass of audio-visual and textual data in terms of an "open" archive, that is: multi-variant access, multiple interfaces, no filtering meta-data, no unifying index, not reducing the raw data to taxonomy, not just tags for grouping and retrieval? The answer is in the software tools developed by the Actice Archive project (Constant, Bruxelles).[38]

William Burroughs "on" tape

For Henri Bergson, time unfolds like a "tape running between two spools", as expressed by Timothy Scott Barker.[39] Paul Bowles' 1966 novel *Up above the World* is about magnetic tape experiments. One chapter in Steven Connor's work on *Beckett, Modernism and the Material Imagination* is called "Looping the Loop: Tape-Time in Burroughs and Beckett". For William Burroughs, human memory itself functions like a tape recording machine: "remember that your memory bank contains tapes that you have ever heard ... press a button, and a news broadcast you heard 10 years ago plays back"[40] like an Mellotron sound sampler. Once this analogy is admitted, it extends to electronic time-stretching as well.

William Burroughs and Brian Gysin experimented with paper cuttings for poetry composition. While this surrealist poetry tradition remains within the regime of the symbolic, the magnetophone tape "cut-ups" which Burroughs started in 1959 subsemantically manipulates the voice itself, transforming its acoustic signals[41], much more radical than (contemporary) Beckett's Krapp, resulting, among others, in the 1981 LP edition of Burrough's magnetophone experiments, the album *Nothing here but the Recordings*. The split between the symbolic wording (literatur) and the real signal articulation (sound culture) takes place in machines: typewriter and phonography.

Burroughs, in his piece *The Ticket that Exploded*,[42] considers language as function of the word "virus" which pre-historically has chosen man as its host for symbiosis. Magnetophonic tapes once more have the capacity to infiltrate humans. This mirrors the actual technological process indeed where the electrically transduced voice signal induces an analog magnetization on the by-passing ferrogmanetic tape (and reverse). Cut-ups are possible only on tape (Fritz Pfleumer's "singing paper" from 1927, not on wire, as originally invented by Oberlin Smith and Valedmar Poulsen's wire recorder) and allow for non-linear jumps and loops unknown from phonographic time axis manipulation which still remains linear - closer to the cinematographic montage. Once language is recorded, it can be arbitrarily edited.

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[38]See Cox / Murtaugh / Mallevé, xxx, in: Ina Blom / Eivind Rossaak (eds.), Memory in Motion, xxx

[39] Time and the Digital. Connecting Technology, Aesthetics, and a process Philosophy of Time, Hannover, New Hampshire (Darmouth College Press) 2012, 59 f., referring to: Henri Bergson, The Creative Mind, N. Y. 1934/1992, 164

[40]As quoted in Joe Banks, Rorschach Audio. Art & Illusion for Sound, London (Strange Attractor Press) 2012, xxx

[41] As explicitely referred to in Kittler's *Grammophon Film Typrewriter* 1986: 167

[42] New York, NY (Grove Press) 1987

The philological risk is that Burroughs scholarship reduces his language "virus" thereme to the idiosyncratic mind of the author. Such visions are rather a symptom (articulation) of a techno-trauma induced by the magnetophone and an epistemological which is cybernetics: be it machines or animals, once coded (be it the human acquisition of language, or source codes implemented as software in computers), both are subject to the symbolic order and become compatible as systems.

In the "writing machine" section of *The Ticket That Exploded*, Burroughs locates the writing scene itself within the technological artefact: inner media theatre, "a room with metal walls magnetic mobiles under flickering blue light and smell of ozone"[43], which obvisouly is the inside of a magnetophone based on thermionic tubes.

In Burrough's experiments with time-axis-manipulated voice recordings, the temporal event is fragmentized: magnetophonic cut-ups of human language, as described in his manifesto *The Electronic Revolution* (1970). Nothing here but the recording? In *The Ticket that Exploded*, Burroughs "[...] took seriously the possibilities for the metonymic equation between tape-recorder and body. He reasoned that if the body can become a tape-recorder, the voice can be understood not as a naturalized union of voice and presence but as a mechanical production with the frightening ability to appropriate the body's vocal apparatus and use it for ends alien to the self."[44]

Already in Platon's primordial critique of alphabetic writing *Phaidros*, the real "dialogue" is not between philosopher Socrates (which is rather an invention by Platon himself) and his pupils (the deceptional "content"), but between reader and writing. This corresponds with KLP where the script notes asymmetric dialogue partners: "KRAPP" and "TAPE". By externalizing the "inner monologue" of human consciousness by mechanical manipulation of tape recordings, Burroughs joins the Turing / Lacan hypothesis that in the moment a human is algorithmically processing sequences of symbols (bei it numbers in mathematics, be it letters in writing / reading), he / she is in an operative (rather theater-performative) mode and becomes machine itself. It is not by coincidence that Alan Turing (1936) models his algorithmic machine according to the newest electronic medium of his days: the magnetophone, with the "write / read head" moving across an (ideally) endless tape.

Sono-chronic tunneling of historical distance

The inverse meaning of the term "contemporary" is the *entanglement* of times which have been traditionally clearly separated on the time line.[45] The reverse of the delayed present is the specifically media-induced "re-presencing" of the past: technological ways of re-generating and re-storing present moments.

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[43] TTE: 62, quoted here after Hayles 1999: 216

[44] Katherine Hayles, How We Became Posthuman. Virtual Bodies in Cybernetics, Literature, and Informatics, Chicago: University of Chicago Press, 1999, 211, referring to William S. Burroughs, The Ticket That Exploded, New York (Grove Press) 1967, 49

[45] See Daniel Rosenberg / Anthony Grafton, Cartographies of Time, New York (Princeton Architectual Press) 2010

In Marcel Proust's *Recherche*, involuntary memory stems from material objects like the Madeleine cookie. In Walter Benjamin's paraphrase, the past here is "unmistakably present in some material object or in the sensation which such an object arouses in us"[46]. But there is another present in the past which does not adhere to the material artefact in *stasis* but emanates from a processual unfolding: like images re-played in electro-magnetic induction from magnetic video tape. There is a wave / matter - dualism in affective re-presencing, oscillating between "presence in default" and "in default of presence".

Electronic storage media for audio-visual re-play generate a presence of the past by actually addressing the perceptual nerves within the human in signals, not by symbols (such as historiographical texts) which require de-coding and address the cognitive mind (where historical modelling takes place). Tele-communication is mostly associated with the bridging of spatial distance by communication media (Shannon), but actually it extends to temporal distance as well when by signal-recording media the temporal gap is being un-done in favor of immediacy in the moment of re-play.

There are technical conditions "under which the absent past can be said to have 'presence' in the present" indeed.[47] The affective present-in-absence is central to technological media especially in the sonosphere. The absence here is the phenomenal dissimulation of the technological apparatus of signal (re-)production in favor of a "Sirenic" presence - Sirenic in the sense of human-like presence generated by machines.

Rigorous attention to material signals and machines escapes the risk of falling into a romantic orientation here.[48] The perceptual, phenomenomal impression of immediacy of the past when listening to the recorded human voice is a function of a concealed technology; the acousmatically hidden sound source has become techno-*logos* in the phonographic apparatus - which, in times before "hight fidelity" sound, has been still very present, both materially and in its self-co-expression as noise.

All temporality experienced by humans is in a constant present, as expressed in Henri Bergson's famous "memory cone"[49] where past perception is always compressed within perception of the present. "For beings living in the Now [...] not even past and future exist if not re- or pre-presented, respectively."[50] But while phenomenology makes use of such neuro-cognitive modelling (Husserl's "time diagrams" of perception of the present inbetween *retention* and *protention*), media archaeology tries to precisely identify the rather different operations of micro-technical signal transduction. All of the sudden, the top of the Bergsonean

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[46] Walter Benjamin, On Some Motifs in Baudelaire, in: same author, Illuminations, New York (Schocken) 1969, 158

[47] Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333 (323)

[48] Goddard 2014, p. 13

[49] Special thanks to a critical reader of this text, Marcus Bastos

[50] Georg Franck, Zeit und Geschichte / Time and History, in: Beiträge der österreichischen Wittgenstein Gesellschaft, vol. XIII, ed. Friedrich Stadler / Michael Stöltzner, Vienna 2005

cone returns in the pick-up of a gramophone needle.

Sonic memory is arbitrary triggered by technological re-play such as a music record at the press of a button. Is what happens then "the re-living of an event that has already happened in linear time rather than an event as if it were happening now in repetitive or cyclical time"[51]? Does technology, even if invisible as it acousmatically is perceived, make a difference to the quality of "presence" perceived? The con-temporary condition is technological.

Different from reading textual records from the past which need to be cognitively decoded (alphabetic symbols and words), with every listening to an ancient recording a gap between time-affect and historical cognition opens. Ears can perceive nothing but acoustic presence, while the historical imagination induced by linear writing takes place in the mind exclusively. The media-archaeological sense of *arché* tries to dislocate this acoustic imaginary.

There is a specific difference between the photographic *punctum* as described by Roland Barthes for visual short-cuts of temporal distance and phonographic *re-presencing* of the transitory impressions of sound art. The articulations of sound art are time-objects in themselves.

The physical presence of any acoustic situation (which is the "real" of vocal frequencies) short-circuits the "historical" distance, when e. g. the myth of the ancient Siren singing is tested against the signals of a sound-generating medium (the technical *aerophone*) on the spot of the Homeric Siren scene, the Li Galli islands close to the Amalfi coast in Italy.[52] Emphatic historical past and techno-cultural present fold into one con-temporary condition.

Especially voice recording enables direct contact that is separated when history time is stretched out on a continuous line[53] - a temporal "fold" (Leibniz) enabled by technology.

On the micro-physical level of technologies (transducing analog signals and processing digital data), there is a direct time-critical link between the (tempo-)real and the symbolic at the complete expense of the imaginary called "history".

The tempor(e)al interlacing between archiving the present and re-presencing the archival past becomes precarious when the focus is on traumatic memory. While a lot of such studies in concentrate on Holocaust and extreme war time experience in terms of historical eventality, the media-archaeological analysis more radically assumes that a traumatic irritation which is communicated by recordings of witnesses, like Claude Lanzman's notorious documentary *Shoah* where the viewer is affected or even "co-traumatized" (Jan-Claas van Treeck), already (*en arché*) stems from the technological setting itself which continuously challenges and irritates the human sense of presence as it was familiar in traditional textual, pre-signal

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[51] Ben Anderson, Recorded music and practices of remembering, in: Social and Cultural Geography, vol. 5, No. 1, March 2004, 3-19 (17)

[52] See W. E., Towards a Media-Archaeology of Sirenic Articulation. Listening with media-archaeological ears, in: The Nordic Journal of Aesthetics, No. 48 (2014), 7-17

[53] Geoffrey Winthrop-Young, Siren Recursions, forthcoming in: Kittler Now, ed. Stephen Sale / Laura Salisbury. Cambridge (Polity Press), note 5; http://phenomenologymindsmedia.files.wordpress.com/2011/05/winthrop-young-siren-recursions.pdf

recording culture.

Future in the past: phonographic storage driven by a virtual trauma

Some phonographic recording and subsequent transcription of oral memory cultures has been undertaken for philological purposes like the recording of *guslari* epic songs in former Yugoslavia by Milman Parry and Albert Lord have been made primarily for the purpose of academic analysis, to answer by anachronistic analogy the "Homeric" question of how extended oral poetry works in a culture without writing. But in early twentieth century a couple of comparable projects in ethno-musicology such as performed by the Berlin Lautarchiv (resulting from prisoner recordings in World War One) are a technological function of traumatic anxiety about the disappearance of indigenous cultures, resulting in techno-archiving practices in the temporal mode of "future in the past". There is an anticipatory "Future in the past": archival storage driven by a virtual trauma of extinction. The monumental ethno-musical recording projects by the Phonogram Archive in Vienna and the Berlin Phonogram Archive (since 1900) were driven by the phantasm to counter-balance the anticipated future modernization or even extinction of existant sound cultures with technical audio-signal registration - a true techno-traumatic impulse.

Mary Ann Doane expresses the aim of this media-archivographical drive: "[...] to retrieve everything possible, driven by a temporal imperative (before it is 'too late') and the anticipation of a future interpretation [...]."[54]

Just like Alan Lomax' notorious recording of American folk songs had been commissioned by the Music Division of the Library on Congress, the same institution commissioned Paul Bowles (an American resident in Algier) to record native Maroccean folk songs and rhythms on magnetic tape (financed by a Rockefeller Fondation Grant) in 1959. Bowles' initiative was driven by the fear that recently independent Marocco was about to destroy that native folk music culture in an effort of national modernization.

The pre-emptive media archive embodies a time-reversed trauma, known from grammar as "future in the past" *(futurum* exactum), arising from the technological condition of photography, cinematography and phonography itself: the concept that a cultural articulation might *possibly* be extinguished and thus in anticipatory ways needs technical pre-recording.

This temporal figuration in culture runs parallel to the even more time-critical operations in World War II electronics when analog, then digital computers performed predictive calculation of enemy moves in real time, applied to anti-aircraft defence, by literally *calculating* future in the past. Nowadays, such predictive analytics algorithms is exercised for profiling of potential terrorist attacks by the NSA in the survey of current telecommunication data. This is no archive from the past any more but actually an archive of the future, taking place in the contemporary.

The present can be delayed as after-effects as well as in anticipation. Just like the ethno-musical phonographic archives established in Vienna and in Berlin around 1900, and the photographic expeditions undertaken by Albert Kahn for his Parisean *Archives de la Planéte* in the 1930, Bowles' Marroccean folk song recordings was driven by a kind of anticipatory trauma that the indigene culture he referred to was about to be extinguished. Appararently he never

[54] Doane 2002: 222 (as quoted in Hadjioannou 2012: 174)

listened himself to the tapes he feverishly recorded; almost forgotten they time-invariantly rested in magnetic (rather than cultural) latency until they were discovered for re-play.[55]

Such technical storage is not collective memory but a collection of recordings meant as memory of an anticipated *futurum exactum*, driven by a virtual trauma of extinction. The archival potential of phonographic recordings "came at a time when many indigenous cultures were already severely threatened, or had already disappeared, ironically as a result of the same Western industrialization that produces the technology used for the documentation. [...] the fact remains that the technology provided a literal documentation that surpassed the results of even the most sensitive transcriber. <...> many ethnomusicologists were so conditioned by Western muscial practice that they intepreted what they heard and transcibred it according to Western musical notation, ignoring the microtonal variations that can still be heard on original recordings. Therefore, such objective documentation can be said <...> to preserve the aural artifacts of a culture"[56] - in facts its sonic temp*aura*lity. The technical recording (that is, the media-archaeological ear) preserves acoustic signals which might have already been obscured by symbolically coded cultural memory.

Disembodied voices from analog to digital analytics

At the end of World War II, the German Service of the BBC recorded voices of survivors immediately after the liberation of the concentration camp Bergen-Belsen to be broadcasted repeatedly *via* radio. Such recordings are preserved in the Phonothek of Deutsches Rundfunkarchiv in Wiesbaden. There is a momentum of temporal indexicality in such signal-witnessing, as expressed in the CD Booklet of the re-edition of these recordings.[57] The medium specificity embodies the character (or even timbre) of that epoque much more indexically than any printed text might ever achive - or *archive* in alphabetical transcription. Such *signal memory* allows for (and incites) new kinds of rather signal-b(i)ased linguistic analysis software like Praat. Such an analysis is less an emphatic recall of past sounds, but - in a kind of time-lense - a media-active archaeology of the *passing* in the vocal present itself which is not logo-centric any more but unfolds as something which is always already past when articulated.

Media technologies starting with photography have been associated with attempts to communicate with the dead - a "spectral logic" of re-presencing.[58]

Derrida defines his time sensation in voice recording: "I am always overwhelmed when I hear the voice of someone who is dead, as I am not when I see a photograph or an image of the

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[55] See Hans Ulrich Gumbrecht, Latency (forthcoming)

[56] Barry Truax, Acoustic Communication, Norwood, N. J. (Ablex) 1984, 118

[57]They have been published on Compact Disc by the Institut für Zeitgeschichte (Munich / Berlin) 2003 *Dokumentation Obersalzberg. Tondokumente. Täter Gegner Opfer*, ed. by Albert A. Feiber / Volker Dahm, track 20 and 21

[58] See Amit Pinchevski and Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial, in: Public Culture 22:2 (2010), 265-291 (283, quoting an expression by Jacques Derrida and Bernard Stiegler, Echographies of Television, Cambridge (Polity) 2002, 117)

dead person"[59] - in spite of the Barthean *punctum*. "I can be touched, *presently*, by the recorded speech of someone who is dead. I can, *here and now*, be affected by a voice beyond the grave."[60] But this spiritism overtone only takes place with analogue media and abruptly ends with digital data processing.

Discussing the essence of the *tone*, G. W. F. Hegel defines it in its temporal essence: "Ein Verschwinden des Daseins, indem es ist"[61]. - a disappearance of being, while it exits. This dramatically changes with sound recording media and with automata for continuous tone generation (the pneumatic organ, the electroacoustic synthesizer, and radio carrier wave oscillators). Whereas the archival record - as linear textuality - is conceptually linked to the historical past, signal recording triggers the temporality of latency - which is *implicit* presence of the past.

The audio engineering software Audacity allows e. g. for automatically tagging both intentional and non-intentional (even traumatic) "silence" in audio files - inaudible sound where time itself speaks, as provided by the "Analysis"-toolbar of the audio software Audacity under the explicit term of "Silence Finder". The "Effects" tool, on the other hand, allows for "removing silence" or to create "echo" from audio signals, which is manipulation of the sonic time event on its minutest level. The "echo" itself embodies the time figure of delayed presence or even "archiving presence": Only recorded presence can be echoed. In reverse, the echo is a temporal mirror of presence itself, thereby undercutting any clear observational distinction between presence and past.

RESONANCE OF SIREN SONGS

Conditioned by the vocal alphabet

Homer´s *Odyssee* has been among the first oral poetry registered by the vocal alphabet as the very condition of passing Homer´s epics in a post-oral poetry age. According to Barry Powell's thesis, the explicit addition of single vowel symbols to the known Phoenician alphabet has happened in early Greece for the xpplicit purpose of recording Homer´s epic.[62] Thus the sonicity of the human voice which resides in vowels could be registered in an early form of grammo-phony.

According to Marshall McLuhan, different from its actual massage, the content of a new medium (or rather cultural technique, in this case) is always the previous one. For literally *gramma*-phonic literature in alphabetic writing, this is oral poetry.

With explicit letters for notating phonetic vowels, what had remained exterior to writing - the voice, as poetically expressed by the Siren songs - enters the writing scene itself. This "heating" of writing has a hypnotic consequence.

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[59] Jacques Derrida, Above all, no journalism, in: H. de Vries / Samuel Weber (eds), Religion and Media, Stanford, CA (Stanford University Press) 2001, 56-94 (71). See Scannell 2014: 126

[60] Derrida 2001: 71

[61]G. W. F. Hegel, Enzyklopädie (1830), § 459 (= Werke, Frankfurt/M. 1970, vol. 10, 271)

[62] Barry B. Powell, Homer and the Origin of the Greek Alphabet, Cambridge 1991

The theoretization of the Siren songs requires a differentiation between sound as physically measurable and (Fourier-)analyzable event on the spot as opposed to symbolically written sound as phonetic alphabet.

Auralization of Sirenic voices

Auralization makes implicit, latent sonic situations explicit, that is: accessible for human hearing. This method becomes a tool, an auxiliary science (German "Hilfswissenschaft") for exploring a new kind of sources (rather than "evidence" which is a visual term) in historical research. Not only room acoustics in closed spaces but past sonospheres thereby become accessible again. Different from textual literary records which do not allow for an experimental reconstruction of the author's original mind-setting, archeoacoustics places the "observer" in a co-original listening situation.

Facing the Amalfi coast south of Naples, the Li Galli islands (Gallo Lungo, Castelluccio and La Rotonda) have been known since antiquity as home of the Sirens. The media-archaeological question is this: It there something like a physically given setting, a grounding in the "real" of signal processing, that kept cultural memory insisting on that place?

According to Homer, Ulysses could hear the Siren song just because a divine power (a *daimon*) calmed down the sea around the Siren islands to get a perfect signal-to-noise ratio. If there were waves, they were silent like ultra-sonic radio frequencies to not resonate in human ears unless a radio receiver demodulates them down to low-frequency loudspeaker emission.

While being addressed by the Sirens' singing, Ulysses is not only in a boat *on* the sea but *in* the waves. The human ear perceives kinetic impulses (the acoustic waves) rather affectively than consciously.[63] The optical regime is about immediate impressions while keeping physical distance; sound in a different haptic way directely attacks the body. With the absence of ear-lids, there is almost no escape to the acoustic attack once the visitor enters a sonosphere. This sonic imprisonment takes place on two levels: the manifest level when we listen to an acoustic composition, and the latent level when even what we see as optical event turns out to be a secondary function of sonic eventality - such as the ultrasonic or the fully-electronic image.

A media-archaeological research expedition by members of Humboldt University Berlin (assisted by the Center for Media Arts and Technology Karlsruhe) in early April 2004 experimented with sound propagation at the supposed original place of the Sirens' singing, the Galli Islands. Both synthetic signals (sine tones, white noise) and natural voices (vocalizations of Monk seals, voices of two female singers) were broadcasted *via* loudspeaker. The signals were then recorded along a supposed line along which Ulysses might have approached the Siren Island. The acoustic analysis of the recordings revealed an acoustic effect which tentatively explains the nature of the Sirens myth: The specific position of the islands (two rock formations opposed to a large curved island) results in a deformation of emitted vocal signals by amplification and changes in the timbre.

Fig.: "Spectrogramm of a vocal sung by two female sopranos exploring the Sirens' songs in the

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[63] See Victor Zuckerkandl, Sound and Symbol. Music and the External World, Princeton (Princeton UP) 1956, 204f

midst of the Li Galli islands"[64]

But to what degree is this acoustic latency (as revealed by media-archaeological research) evidence for a conscious use of such reverberations in ancient times?[65] The correlation between this acoustic latency as revealed by cold measuring evidence with a conscious use of such reverberations in ancient times induced by the semantically heated transmission of the Siren songs in the vocal alphabet strikes the central question of cultural tradition when conceived in techno-mathematical terms of communication theory. Any such deduction of sonic significance from archeoacoustics oscillates between signal or noise.[66] What remains undecidable is the degree to which a conscious use of resonance in ancient times has been applied to such acoustic settings. But the key hypothesis based on such findings is that the data won by acoustic measurement correlate with essential assumptions in ancient Greek musical theory and enharmonics. The clue to the location of the Siren songs might therefore be that the sonosphere specifically struck the Greek ear which was tuned by its culture of musical listening.

(Hyper-)Sonic beams

The poetic subject of the Siren songs is rooted in writing, a kind of epic phenotype of the cultural-technological genotype of the alphabet.[67] Sound can be symbolically registered only in its specification as *vocal* alphabet, but only with the media epistemic condition of technical signal recording the media archaeological investigation of the Siren motive arose in non-philological ways. In the age of acoustic media, sonic hallucinations such as the Siren singing is not a function of phonetic writing any more but of technical signals. That is why the Siren voices Ernle Bradford claimed to have heard at the Sirenuse islands appeared "soul-less", "somewhat im-material"[68]. It requires a special device (method) to decode these acoustic memory grooves: the media-archaeological gramophone, i. e., an archaeology of sound.[69] Synthesis of the voice deceive the human ear. Brain wave simulators, just like MP3 audio file compression, are built on both psycho- and media-acoustic facts. An ultrasound packet,

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[64] From: Karl-Heinz Frommolt / Martin Carlé, Der Gesang der Sirenen. Homers Dichtung und akustische Realität, in: Hugo Fastl / Markus Fruhmann (ed.), Fortschritte der Akustik. Plenarvorträge und Fachbeiträge der 31. Deutschen Jahrestagung für Akustik DAGA 2005 in München, Berlin (DEGA), vol II, 797

[65] See C. Scarre / G. Lawson (eds), Archaeoacustics, 2006

[66] The borderline between culturally intended sound and implicit acoustic settings separates "prehistoric" sonic articulation from its cultural history not only in a temporal but in a structual sense. See Chris Scarre / Graeme Lawson (eds.), Archaeoacustics, Cambridge et al. (McDonald Institute for Archaeological Research) 2006

[67] Barry Powell, Homer and the Origin of Writing, Cambridge 1991

[68] Ernle Bradford, Ulysses Found, London (Hodder and Stoughton) 1963, 156

[69] "Versuchen wir eine akustische Archäologie." Friedrich Kittler, Das Alphabet der Griechen. Zur Archäologie der Schrift, in: Knut Ebeling / Stefan Altekamp (eds.), Die Aktualität des Archäologischen in Wissenschaft, Medien und Künsten, Frankfurt/M. (Fischer) 2004, 252-260 (260)

whatever it contains, is only heard in the head of the target person, where the skull bones function as a resonator which changes the hight frequency waves back into audible sound, that is: demodulation, just like with radio waves.[70]

Phonographic sirenism

The human voice became media theatre with the arrival of the Edison phonograph. With an analogous human / machine performance in the New York Carnegie Hall, the Edison Company in 1916 convinced the (literally) *audience* (not sight-focused, like in traditional theatre) of the sonic fidelity of phonographic recording: "Alone on the vast stage there stood a mahagony 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"[71]; a similar confrontation between performance with human voice and replay from the apparatushas been commented in the *Boston Journal* the same year: "It was actually impossible to distinguish the singer‘s living voice from its re-creation in the instrument."[72] The Homeric Siren motive returns as the sonic variance of the Turing Test in coded communication[73], as much as *His master´s voice* has been experienced by the dog Nipper as the phantasmatic illusion of being present, induced by technical *recording*.[74]

This extends to the time axis as well. Communication between the human sensory apparatus and the signal record can short circuit historical distance, since phonographic culture has been apparently been accommodated to the disembodied voice. But a cognitive-affective dissonance remains. While the historically trained mind knows that the phonographic mediated voice is actually absent, acoustically it is very much "re-presenced" (Vivian Sobchack).

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[70] Olaf Arndt, Wer nicht hören will muss fühlen (Voices of the Mind III), in: Babel No 4 (May 2004), 32-41 (38), referring to the *Dictionary of Non Lethal Weapons* edited by John B. Alexander

[71] Article "Edison Snares Soul of Music", in: New York Tribune from 29th April, 1916, 3, quoted here after: 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

[72] 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

[73] Alan Turing, Computing Machinery and Intelligence, in: Mind vol 59 (1950), 433-460

[74]See Mladen Dolar, The Voice and Nothing More, xxx

Artificial voices, uncanny

Exactly when the Sirens appear to perform the most beautiful in human articulation - the musical voice -, they remind of the uncanny in human experience of electro-acoustic voices: a reminder that the apparently most intimate voice might be machinic in itself, and that the human hearing apparatus is not able to separate human from inhuman voices.

Maurice Blanchot has desribed the Siren sound as paradigmatic for what can be re-defined as media-cultural state of uncertainty. In the age of voice synthesis, humans can not be sure any more whether the sounds they are confronted with are organic or technologically produced.

Located between the extreme borders of "signal" on the one hand (Homer lets them sing in Greek language) and "noise" on the other, the sono-poetic trope of the sound of Sirens offers itself to theoretization in terms of communication theory. Only in written literature the Siren sound became defined as lyrical. The media-archaeological ear, on the contrary, recognizes sine waves.

GUSLARI *ON-LINE*. A technological interpretation of "oral poetry"

Electrified memory

The legacy of Milman Parry's and Albert Lord's research into "oral literature" can not be reduced to philological transcriptions, but encompasses their audiovisual archive of phonographic recordings as well.

A radical change from symbolic transcription to signal recording of oral poetry took place with the magnetophone. „Even Homer's rosy-fingered Eos changes from a Goddess into a piece of chromium dioxide that was stored in the memory of the bard and could be combined with other pieces into whole epics. 'Primary orality' and 'oral history' came into existence only after the end of the writing monopoly, as the technological shadows of the apparatuses that document them."[75] Magnetic recording of oral poetry operates not "beyond", but below symbolic textuality, with the actual signal.

Even if it does not make a crucial difference for cultural memory, oral poetry becomes a different existence if it is not mechanically recorded by phonograph or gramophone which is - as its very name suggests - still close to graphical "writing", but electronically on magnetic wire or tape, as performed by Albert Lord on the same ground around 1950? Apart from being of a different technological essence, such recordings stimulate a different kind of scientif analysis which is not just philological or musicological any more but researches the sub-semantic poetic articulation on the media-archaological level (spectral analysis with electronic measuring media), thus revealing evidence of a different (but still poetic?) kind.

With phonograpic recording of the real voice, an irritation of the temporality of cultural memory took place. Next to the traditional notions of archival historicity, with the recordability of oral poetry as a physical audio-event (not just symbolically like in the phonetic alphabet) a

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[75] Kittler 1999: 7, referring to: Walter]. Ong, Orality and Literacy. The Technologizing of the Word, London 1982, 27

kind of freeezing of past performances takes place whose media-inherent temporality differs from the established notions of cultural memory. Such technologies allow for almost time-invariant cultural feed-back: What happens when such a recording is being re-played these days to the local culture in Serbia from previous sound recordings using the same device? On the other hand, are contemporary oral poets (*guslari*) similarly positioned when recorded with a re-enacted Webster Wire Recorder like Albert Lord had applied half a century ago?

And further, the digital processing of such recordings for analysis is not just another technical extension; it rather transform the very essence of oral poetry. In a crude way, algorithmic processing of poetic rhythms, as genuinely re-generative, might be closer to the "formulaic" principle detected by Parry than any other kind of technical reproduction was before.

The tradition of songs and tales, for millenia, happened in mnemotechnics of oral transmission, increasingly accompanied (supplemented, deferred) by notational writing which symbolically tried to emulate the musicality of oral speech (the vocal alphabet, musical notes). The 20th century enabled a media-induced re-entry of orality, a secundary orality (Walter Ong) based on analog recording technologies like phonography and magnetic tape and cinematography. In the 21st century, a symbolic notation has re-entered, this time actually sub-alphabetically analyzing the sampled event in the form of the alphanumeric code within computing. For digital audio files, the media-critique of writing as recording device, articulated once by Platon in respect to the ambivalence of technical memories, has to be rewritten.

From this situation arises the „archival“ question: What happens to the genre of oral poetry when the "online"-instrumentation (the *gusle* string) and the "online"-recordings (literally Lord's wire spools) become accessible "online" (in the World Wide Web sense)? A note to Ismail Kadare's novel *The File on H.* emphasizes: "In fact, part of the Milman Parry Collection of Oral Literature at Harvard has been digitized, and it is now possible to hear some of their field recordings *online*!"[76]

Re-discovering the sound of "texts": Oral poetry

While Florens Chladni was already experimenting with visualisations of acoustic wave figures in sand as created by the vibrations of the violin bow, Goethe's definition of literature did not even mention "acoustic data flows"[77] which concern oral poetry.

The practice of oral tradition has been silenced by the general textualisation and „only survived in written format; that is, under pretechnological but literary conditions. However, since it has become possible to record the epics of the last Homeric bards, who until recently were wandering through Serbia and Croatia, oral mnemotechnics or cultures have become reconstructible in a completely different way“, Kittler writes referring to Walter Ong's study on the technologizing of the word.[78]

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[76] http://www.amazon.com/File-H-Novel-Ismail-Kadare/dp/1559706279; accessed September 22, 2006. For such "online" recordings, see http://www.chs.harvard.edu/mpc

[77] Kittler 1999: 7

[78] Kittler 1999: 7, referring to Walter Ong, Orality and Literacy: The Technologizing of the Word.

The usual media-critical argument (since Platon's dialogue *Phaidros*) is that alphabetic recording kills the living memory culture of oral poetry by dead letters. At a recent conference organized by the Milman Parry Collection at Harvard University), one topic has been „The textualization of oral traditions“.[79] Has Parry's theory of formulae-based oral poetry itself been an effect of its analysis in a transcribed, thus: textual form - just like Aristotle gained his insight into the phonetic character of speech only after its literary elementarisation by the phonetic alphabet? The alphabetization of phonographically recorded oral poetry in philological studies (Homer studies, classics) lead to an oblivion of its essential nature which is sound. In a somewhat oxymoronic and at the same time significantly honest way, the name given by Albert Lord to the impressive archive of recorded oral poetry from the former South Yugoslav countries located at Harvard is "Milman Parry Collection of Oral Literature" by now. But media-archaeologically recognized, there is no text but recorded voices and sound, which only afterwards became transcribed into literature and musical notation (among others, by Bela Bartók).

The signal-based recording of oral poetry operates not "beyond", but below textuality (both subliminal in the neuro-physiological sense and "sublimely" in the poetic sense).

Memory in the age of electro-mathematical media has become transitory, more than ever known from so-called oral cultures. In analogy to Ong's famous analysis, a kind of "second mem/orality" takes place.

Transcription *versus* technical recording

Since the Edison phonograph, for the first time, the sound of language could not only be recorded symbolically (as by the phonetic alphabet), but as a real audio signal. The archaeology of sound at stake here is "closely connected to recording technologies that simultaneously <...> shape our sensory experiences of oral poetry".[80]

The "musical" aspect of oral poetry performances lies not in its harmonic (melodic) but its rhythmic aspect - the chrono-poetic and time-critical aspect of prosodic articulation.[81] Only highly sensitive measuring devices (as applied in computational ethno-musicology or in the micro-tonal analysis of piano play) can analytically cope with the subtleties of such *chronoi* (Aristoxenos).

In the case of the legendary *guslar* Avdo Mededovic, Parry and Lord recorded 45000 poetic

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London 1982, 27 „and (more reasonably) 3“

[79] *Singers and Tales in the 21st Century: The Legacies of Milman Parry and Albert Lord* (December 3-5, 2010), on occasion of the 50th anniversary of the publication of Albert Lord’s seminal *Singer of Tales* and the 75th anniversary of the death of his mentor Milman Parry who has developed the Oral-Formulaic Theory)

[80]Peter McMurray, There Are No Oral Media? Aural and Visual Perceptions of South Slavic Epic Poetry, typoskript of a talk given on occasion of the Milman Parry half-centennial conference at Harvard (see footnote above)

[81]See Wallace Chafe, Discourse, Consciousness, and Time. The flow and displacement of *conscious* experience in speaking and writing, Chicago 1994

lines on phonographic discs, and 33500 lines in manual transcription.[82] In order to subject (and open) cultural articulations like "oral poetry" to academic research, these speech and sound events first had to be symbolically or technologically recorded and archivized in order to slow them down for careful and detailled analysis. Time axis manipulation ("slow motion") is the *a priori*, the condition for the scholarly analysis of time-critical processes which Edmund Husserl once called pro- and retention - which in terms of neuroscience is the three-second time span ("window of presence") for a sung verse line (such as an ancient Homeric hexameter).

In listening to such songs from the Milman Parry Collection online, one tends to be trapped by the referential illusion, believing that we are confronted with the audio signal. But in fact discrete bit-strings are being processed - sublime textuality, operating on the subliminal level of our understanding - an unexpected technical realization of what Gottfried Wilhelm Leibniz once described as unconscious ("nesciens") mathematical calculating perception (when listenting, f. e., to breaking waves at the sea shore).

While "analog" phonographic signal recording has been "beyond textuality", a different textuality returns powerfully within technomathematical machines. The alphabet returns in a secondary writing, which is: the alphanumeric code - even if disguised as „secondary orality“.

In the mid-1930s, Harvard scholar Milman Parry investigated the South Yugoslavian unwritten memorizing techniques of epic singers (the *guslari*) as a living analogy to Homer's ancient singing. Not directly the phonographic sound recordings on aluminium discs but their symbolic transcriptions formed the analytic basis for the resulting theory that the hour-long oral tales were regenerated for each occasion from a stock of existing formulae (the formulaic theory of oral poetry).

In 1950/51, Parry's assistant Albert Lord returned to the scene to repeat or continue some of the first recordings, sometimes with the same singers. But this time he used a new technology, a magnetic recording device (based on steel wire). Which difference does it make if popular song recording does not take place gramophonically on aluminium discs any more but electro-inductively *happens* on magnetic medium? Mechanical recording is a passive storage techology; electromagnetic recording, though, requires a dynamic re-enactment to be reproduced.

A wire recorder like the "Webster Chicago" used by Lord is not a phonograph, which, as the name suggests, is still part of the tradition of graphical recordings, but instead transforms the sound memory into a different physical state; process of electromagnetic recording and reproduction not a continuation of writing in a new form, but rather a fundamentally different and genuine technical media event born of the very nature of electricity

Technical recording vs. symbolic transcription (Bartok)

Ancient Greeks added vowels to the Phoenician alphabet for the explicit purpose of making the musicality of oral poetry, in fact: Homer's epics, recordable.[83] But this notation is still symbolic,

[82] Gertrud Leuze, Homer und "Oral Poetry". Milman Parrys These und mene ERfahrungen im ehemaligen Jugoslawien, in: Würzburger Jahrbücher für die Altertumswissenschaft. Neue Folge, Bd. 26 (2002), 5-12 (Anm. 8)

[83] Barry B. Powell, Homer and the Origin of the Greek Alphabet, Cambridge 1991

like the musical transcription which Bela Bartok provided for Milman Parry's recordings of Guslari songs on aluminium disc. What the discs were able to record, though, was a surplus: the non-musical articulations, noise or bird-singing in the background, even Avdo Mededovic's coffing.

A „Webster Wire Recorder“ had been used by Albert Lord for his South Yugoslav recordings of oral poetry. When a *guslar* sings into the wire recorder microphone accompanied by his *gusle*, a knee-held violin, a correspondence between the vibrations of the vocal chord, the string (horse-hair chord) that is being bowed, and the recording wire (steel) takes place. In such oscillations, the most human is at the same time the most inhuman - when the machine with its coldest technical ear listens to poetry.

Different from notational transcription into musical scores, technical signal-recording of cultural articulation allows for the electro-physical measuring of recorded events (digitally done by "sampling"). This subjects the cultural event to experimentation, thus enabling a non-hemeneutic analysis of cultural articulation on the sub-philological, even sub-alphabetic level.

So not just oral poetry was recorded but as well noise, while the transcriptions into musical notation treat the sonic event as "oral literature" (as the Harvard Collection actually calls itself), thus keeping the analysis within the disciplinary discourse of philology (Parry) and musicology (Bartók), reintegrating sound into the symbolic order.

Singers and Tales in the 21st Century: digital memory

The Legacies of Milman Parry and Albert Lord at the end of the 20th century became transformed into digital files (both the textual and pictorial documentation of the Yugoslavian research journeys and some of the recorded Guslari songs themselves). Does this digitization (by sampling) transform the essence of such a memory? And which is the new "archive" to which such files *online* give access?

The tradition of songs and tales, for millenia, happened in mnemotechnics of oral transmission, increasingly accompanied (supplemented, deferred) by notational writing (the vocal alphabet, musical notes). The early 20th century enabled a media-induced re-entry of orality, a secondary orality (Walter Ong) based on analog recording technologies like phonography and magnetic tape. In late 20th century, the symbolic notation took revenge by its re-entry: in the form of the alphanumeric code within computing. The digital sampling of the audiovisual legacy of Parry and Lord on aluminium discs and wire spools makes a media-ontological difference - even if not to the human ear which is betrayed by the "sampling theorem" of digital signal processing.

Mathematically discovering sub-semantic poetic articulation

It makes a media-archaeological (rather than philological) difference for the notion of "oral poetry" when its notation for analysis does not take place in symbolical writing (the phonetic alphabet since the age of archaic Greece, or more recently, musical notation) any more, but by (electro-)physical recording media like the phonograph, as performed by Milman Parry on aluminium discs. Micro-events in performing oral poetry might thus get under consideration, near-discontinuous change, probabilities of transitions, re- and protentions which require

stochastic rather than simply statistical analysis (known from Claude Shannon's analysis of dynamic toys, described as "Mathematical Theory of Little Juggling Clowns"[84]). Oral poetry can be re-generated by the machine indeed, transforming the *formulae* (as defined by Parry) by algorithms. Claude Shannon defines artificial languages abstractly as "a stochastic process which generates a sequence of symbols"[85] - which is exactly the definition Jacques Lacan gives to the mechanism of signifiers in the human unconscious.

AURALIZATION AS RE-ENACTMENT OF THE SONIC PAST

Introduction

For centuries historical research has privileged the visible and readable archival records, thus fulfilling Marshall McLuhan's 1962 diagnosis of the *Gutenberg Galaxy* being dominated by visual knowledge.

But with auralization, a new kind of "virtual" (that is: numerical simulation-based) historical research has emerged: the research into past sonospheres and ways of listening long-time ago. Auralising makes random acoustic signals audible within a computer-modelled spatial surrounding.[86] This algorithmic tool has mostly been applied for the design of new, that is: *not yet existing* concert halls, or for the restauration of *still existing* halls. But in the interest of historical research even the acoustics of rooms which *exist no more* can be derived from auralization on the basis of computer-based simulation - with all the epistemological ambivalence of "(re-)construction".

Already with the arrival of the phonograph the question arose if soundscapes for the time previous to Edison can be reconstructed. With auralization, a new kind of "virtual" (that is: numerical, simulation-based) method has emerged: the research into past sonospheres and ways of listening long-time ago. An extended notion of sonic heritage emerges from auralisation as re-enactment of the sonic past and acoustic simulation as historical method.

Methods of exploring the sonosphere of ancient Greek theatres by application of mesuring technology have been developed long ago. In the meantime, audio communication has extended its research methods to re-enactments of ambisonics of the past - be it historic concert halls or other architectural spaces and even pre-historic landscapes. Thereby a veritable acoustic media-archaeology is emerging where the term "archaeology" is more than just a metaphor for digging for new records from the past. The paper discusses in case studies its technological means and the kind of new cultural knowledge which stems from that approach. Hermeneutic chances and limits of such re-auralization as new form of historical method and research are being discussed.

To what degree can auralization (sonic simulation based on measurement) provide a new kind of algorithmically synthesized record - and can this record still be called "historical"? Can the strict criteria of what is defined as historical record (German "Quelle") be applied to ephemeral

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[84] See Axel Roch, Claude E. Shannon: Spielzeug, Leben und die geheime Geschichte seiner Theorie der Information, Berlin (gegenstalt Verlag) 2009, 163f

[85] Claude Shannon, Collected Papers, Piscataway (IEEE Press) 1993, 5

[86] As defined in Weinzierl 2002: 20

settings like sonospheres? Here a double meaning of "record" is implied: the traditional textual document in symbolic (alphabetic) code, but recently signal recording of time-varying signals as well. There is a new possibility for tele-communicating with the past, embodied and transmitted in the acoustic records and channels.

As a result of media culture since nineteenth century, the traditional range of text-based, symbolic records of the past has been supplemented by auditive and visual signals. Acoustic signals are defined as time- and/or space-varying physical quantities. In the context of signal processing, not arbitrary on-off-signals but only (analog and digital) signals that are representations of analog physical quantities are considered as signals[87] - thus necessarily always being *embodied* in the material world which remains from the past. To what degree can such an ephemeral time-varying signal like sound be reconstructed? Sounds from the past are commonly associated with recording media like the Edison phonograph. In a more active sense, media-archaeology of past sonospheres implies the technologically active agency of reconstruction, with the measuring media and signal processing methods (impulse response) themselves being the active archaeologists.

Since Edison's phonography sound, noise and voices can be technically recorded and thus memorized, resulting self-expressively in extended possibilties of sonic heritage. Research into past ways of listening have emerged in Science & Technology Studies as a new branch of historical knowledge. Here, the term *sonic environment* is commonly associated with industrial and other sources of noise.[88] Complementary to the social *history* of such sonospheres there is a need for an *archaeology* of sonic expressions.

By auralization as re-enactment of the sonic past, the historical method is not only extended but even pushed to its margins, since the temporal affect which arises from such media-archaeological auralization as "re-presencing"[89] is different from the familiar text- or image-based historical sensations. Historical argumentation as a cognitive operation of organizing past data will never be audible but only readable in complex textual argumentation; the historical method, though, will certainly be extended to sonic articulation as well - pushing the notion of history to its margins.

To what extent is the auralization of past sonospheres a valid historical or an archaeological method of research?

The discipline of history treats the past as a sender system whose receiver are the present historians themselves - a telecommunicative dispositive. Johann Gustav Droysen who in his *Historik* once differentiated between records from the past which were intentionally constructed for tradition ("Quellen") and unintended records as remnants ("Überreste"). When

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[87] Entry "Signal Processing", online http://en.wikipedia, accessed on 25 November 2010

[88]See Karin Bijsterveld, Mechanical Sound. Technology, culture, and Public Problems of Noise in the Twentieth Century, Cambridge, Mass. / London (The MIT Press) 2008, 11 f., referring to R. Murray Schafer, The Soundscape. Our Sonic Environment and the Tuning of the World, Rochester, Vt. (Destiny Books) 1994 [originally 1977]

[89]See Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds.), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333

an old building as a piece of the past is still in use, it turns out "historical" only when being perceived as such by research.[90]

More recently Michel Foucault criticized the discipline of history for turning *monuments* of the past into *documents* to be memorized, even if they are often of non-linguistic nature and of different enunciative qualities.[91] He rather proposes to investigate remnants from the past by reconfiguring them into new elements - elements whose smallest units nowadays are *binary digits*. Even if acoustic spaces which derive from previous times are algorithmically re-sonified, they remain silent in the Foucauldean archaeological sense.

Mesaurement and simulation as two modes of auralization of past, therefore silent sonospheres are not historical methods *per se* but rather what historians call "auxiliary sciences" to the discipline of history (*Hilfswissenschaften*, in German).

The British historian R. G. Collingwood subsumed source-critical history under the general name of "archaeology" for which he lists "departmental sciences such as palaeography, numismatics, epigraphy, and so forth."[92] The ambition of the present paper is to add auralization to this list. "These archaeological sciences are a *sine qua non* of critical history. They are not themselves history; they are only methods of dealing with the soures of history" <ibid.>. "They form, as it were, the bones of all historical thinking."[93]

In its narrative discursive form, "[H]istory itself must be flexible, but it must have rigid bones [...]. [...] the concreteness of history can only be reached through the abstractness of the archaeological sciences."[94] Collingwood in fact describes the archaeological method in terms which can be applied to auralization as well: "The archaeologist feeling his way towards new advances is constantly asking himself whether this or that detail [...] can be proved characteristic of a certain date or a certain origin [...]."[95]

But without historical imagination (usually supplied by philosophy of literature), inquiries into the past remain poor, Collingwood insists. Inbetween now a rule-governed kind of scientifically controlled imagination has emerged: digital simulation and modelling.

The *unprocessed data* provide the archaeological material upon which historiography might be based: "As historical evidence, records are largely unconscious, and not slanted for the consumption of posterity. In this they are therefore akin to the vast majority of archaeological artifacts“.[96] At that point, algorithic data processing comes in - the computer as active media-archaeologist.

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[90]Johann Gustav Droysen, Historik, edited by Rudolf Hübner, Munch / Berlin (Oldenbourg) 1937, 37

[91] See the Introduction to his *Archeology of Knowledge*, xxx

[92]"Outlines of a Philosophy of History" (manuscript 1928), in: Collingwood 1946/1993: 426-496 (490)

[93] Collingwood 1946/1993: 491

[94] Collingwood 1946/1993: 491

[95] Collingwood 1946/1993: 491

Auralization method has been proved to be capable of reproducing prediced room acoustical properties: "When listening to the auralization and comparing to dummy head recordings in the same position in the same room, the differences are hardly audible. The auralization technique has matured to such a level, that the human ear can hardly tell wheter it is a simulation or not."[97] From that an ambiguity of a different kind arises: Uncertainty in human judgement about the validity of an acoustic record concerning a "historical" room. If echoes and reverberations are simulated correctly, "the auralizations from simiulations actually sound more natural than the auralizations using the measurements the real room"[98]. Such hyperreal (in Jean Baudrillard's sense) *Verunsicherung* is well known from an ancient sonospheric setting itself as descibred in Homer's *Odyssee* - the acoustemic challenge embedded in the Sirens' song with its turning the notion of human singing upside down: "Some have said that is was an inhuman song - a natural sound (is there such a think as an unnatural sound?) but on the borderline of nature, at any rate foreign to man; almost inaudible [...]. Others suggested that it [...] simply imitated the song of a normal human being, but since the Sirens, even if they sang like human beings, were only beasts [...], their song was so unearthly that it forced those who heard it to realise the inhumanness of all human singing."[99]

Here, a methodological provocation emerges. Acousticians have a different judgement of the validity of aural simulation than historians. When soundscapes of the past ("auditory cultures") are being reconstructed by historical research, they become nothing more or less than an extension of the historical method - a new "auxiliary science" for historians. Soundscapes of the past are thus integrated (if not subjected) to the discourse of historiography - with terms like "history of sensory perception" (claimed e. g. by Karl Marx and Walter Benjamin).

While the discourse of history as cognitive dimension is bound to writing acts (or oral narrative), auditive evidence (as archived in the past) asks for an alternative approach: media-archaeological re-enactment, leading to a different temporal regime of auditory memory. Media archaeology, which is media studies as exact science, analyses media-induced phenomena on the level of their actual appearance, that is: enunciations in Foucault's terms. In our context this is physically real (in the sense of indexial) traces of past articulation, sonic signals which differ from indirect, arbitrary evidence symbolically expressed in literature and musical notation.

Knowing past sonospheres before Edison

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[96] D. P. Dymond, Archaeology and History. A plea for reconciliation, London (Thames & Hudson) 1974, 67

[97] Jens Holger Rindel / Claus Lynge Christensen, Room acoustical simulation and auralization. How close can we get to the real room?, keynote lecture at WESPAC 8 (The Eighth Western Pacific Acoustics Conference), Melburne, 7-9 April 2003, Manuscript No. 1025J, chap. "Conclusions". On the *approximative* reliability of room-acoustical simulations, see as well Weinzierl 2002: 143 f.

[98] Rindel / Christensen 2003, chap. "Subjective Verification"

[99] Maurice Blanchot, The Sirens's Song. Selected Essays, Bloomington (Indiana University Press) 1982, 59-65 (59)

The traditional *a priori* of the Humanities has been extended by signal-recording and signal-processing media which preserve and transmit what has previously been unaccessible to experience and thereby to understanding in historiography and as history. A different reality of the past is memorized by media which can register more than simply what only exists in writing or in narration - such as the noise of the battles and the sonic effects of artillery.[100] The Phonograph (respectively Emil Berliner's gramophone) registers the whole range of acoustic events.

In his novel dating from 1880, *L'Eve Future*, Vielliers de l'Isle-Adam lets the inventor of the phonograph, Thomas Alva Edison, lament on the loss of sonic information which has been lost in world history as long as this cultural memory was indeed reduced to what could historiographically be written down by the alphabet alone: "Voici tantôt soixante-douze siècles [...] qui, d'ailleurs, à titre de précédent immémorial, controuvée ou non, eût échappé à toute phonographie."[101]

Technical repeatability of recorded sound leads to the option of an almost a-historical sonic re-enactment of the past. But this "archival" approach comes to its limits when research is interested in sonospheres which have never been intentionally be recorded at all such as the acoustics of concert halls from long time ago. At that point, auditory evidence splits into physical and historical. The experimental approach to the reconstruction of auditory perception in the past is a method familiar from sciences: to *actually re-enact* the sound-generating setting. When we pull the string on a monochord in its subsequent intervals we actually experience the technical dispositive which has been the Pythagorean basis for musing about music and mathematis in the past - invariant towards entropic, historical time.[102] In fact, the vibration of the string short-circuits us with that past, undercutting the "historical" divide inbetween.

Delayed presence: Micro-tuning of space and time-reversal in acoustics

"Time machines" are frequently associated with movie-like time travelling such as in H. G. Wells' novel. But it is rather sound and music which allow for the most flexible and dynamic time travelling: a kind of uchronia rther than utopia.

Musical performance is a time machine indeed which on the basic level allows for time axis manipulation on the time-critical micro-level like electroacoustic delay lines or electromagnetic tape delay in early electronic music studios for phase shifting and superposition of sound events.

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[100] See Bernhard Siegert, Das Leben zählt nicht. Natur- und Geisteswissenschaften bei Dilthey aus mediengschichtlicher Sicht, in: Claus Pias (ed.), Medien. Dreizehn Vorträge zur Medienkultur, Weimar 1999, 161-182 (175)

[101] 1880/1979: 34

[102]"Zeitinvariant sind Systeme dann, wenn sie zu unterschiedlichen Zeiten gleich reagieren, d. h. wenn eine Zeitverschiebung am Eingang ein zeitverschobenes, ansonsten aber unverändertes Signal am Ausgang produziert." Stefan Weinzierl, Grundlagen, in: same author (ed.), Handbuch der Audiotechnik, Heidelberg (Springer) 2008, 1-40 (15)

From the microsonic field of samples up to the macrosonic domain of a muscial composition, sound can be sculpted in time.[103] Jacob Kirkegaard's installation *AION* acoustically unfolded the abondoned space inside the forbidden zone of the collapsed nucelar plant of Chernobyl in the Ukraine.[104] In each of the abandoned rooms, Kirkegaard made a recording of 10 minutes which he played back into the same room, then recorded this again - to be repeated up to ten times. As the layers got denser, each room slowly began to unfold *a drone* with various overtones. Kirkegaard's sonic time layering explicitely refers back to Alvin Lucier's installation *I am sitting in a Room* (1969) where the technical set-up created a tempor(e)ality of its own.

Space can be explored by time-critical sound operations; the engineering of room acoustics by measuring operations such as pulse-response (developed by Walter Sabine around 1900) has even been extended to auralization as re-enactment of the sonic past.[105] Architecture is not just an empty vessel to be filled by arbitrary acoustics; the sound is rather been actively processed by the architecturally defined space itself. Spatial extension thus turns out to be the medium of temporal delay, while at the same time space itself becomes a function of temporal measuring. But it takes the memory capacity of an electronic device and its computational processing to provide fugitive sound articulation with a recurrent index of temporal depth - a sonic phenomenon of immediately passed / past tempor(e)ality.

Audio and vision belong to seperate spatio-temporal worlds; bringing them together is not possible without doing violence to their tempor(e)alities.[106] The hearing apparatus is much more sensitive to micro-time-critical processes than the eye. While the flickering of an electric bulb (50 times/sec.) can not be noticed by the after-image in the eye any more (the cinematographical effect), the rising of acoustic pitch from 50 to 100 oscillations/sec. are very well perceived indeed. "History" commonly refers to emphatic, narrative time scales. But there is a micro-history in every sonic event which is a time-signal by definition.[107]

There is a difference between time-based concepts like "cultural history" and time-critical micro-histories based on time signals - smallest run time differences (intervals) between direct sound waves and reflected sound waves in terms of Delta-*t* as remarked by Aristotle in his treatise *On perception* as *to metaxy*.[108] Acoustic signal delay makes "the inbetween", in fact: the *medium* channel sonically opaque. Theater architecture, in terms of its time-critical

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[103] Steve Goodman, Timeline (sonic), in: Matthew Fuller (ed.), Software Studies. A Lexicon, Cambridge, Mass. / London (MIT Press) 2008, 256-259 (256)

[104] DVD, created for his MA degree at the Academy of Media Arts, Cologne, January 2006; see http://fonik.dk/works/aion.html

[105] For an exemplary study see Stefan Weinzierl, Beethovens Konzerträume. Raumakustik und symphonische Aufführungspraxis an der Schwelle zum modernen Konzertwesen, Frankfurt/M. (Erwin Bochinsky) 2002

[106] As has been analyzed by Michel Chion, Audio-Vision. Sound on Screen, Columbia UP 1994

[107] See section "4.1 Temporal structure of the sound field " in Weinzierl et al. 2014

[108] See Aristoteles, Über die Wahrnehmung und die Gegenstände der Wahrnehmung, in: same author, Kleine naturwissenschaftliche Schriften (Parva Naturalia), Stuttgart (Reclam) 1997, 47-86 (76, § 446b)

acoustical feature, becomes "media theatre" in its truest sense: *to metaxy* as run time difference. Binaural acoustics turns out as implicit time-measuring instrument

This difference (not remarked as long as the reflection is so fast in small distance that it is for human ears indistinguishable from the original direct *schall*) amounts to perceptible (and in terms of music halls and audio technology even disturbing) echo effects as soon as the distance amounts to perceptible wave propagation (ca. 330 meters / sec. for sound waves in the air - depending on temperature).

It is by such time-critical measuring methods (impulse response as tool for the analysis of room-acoustics) that spatial models can be constructed, such as with the simulation software EASE. If the acoustic beam is micro-chronologically traced back to locate a listener position, micro-historiography is at work. Spatial order is thereby reconstructed from time-critical pattern.

Recorded sound is temporarily suspended from fading out and thereby becomes time-shiftable in replay, thus escaping historical time. Sonic events evolving in time might even be time-reversed by immediately sending them back to the source, as long as they propagates without losing too much energy to heat consisting of the random motion of individual air molecules instead of their collective movement in the sound wave.[109]

More than just a metaphor: Acoustic archaeology

Let us differentiate between the socio-cultural respectively "collective" (Maurice Halbwachs) memory of sonic events (auditory memory) and the actual (media) recording, measuring and simulation of sonic articulation from the past.

In the research group around the journal *Explorations* and especially in the *Culture and Communication* seminar at the University of Toronto the psychologist Carl Williams borrowed from E. A. Bott the notion of *auditory space*. The phrase was not only metaphorically electrifying, but Marshall changed it to "acoustic space" as the quality of electronic communication spheres.[110]

For an archaeology of the acoustic in cultural memory the human auditory sense does not suffice. The sonic trace can rather be tracked with genuine tools of media studies which is technical media themselves. One way of "acoustic archaeology" is to play a musical partition on historic instruments. But the real archaeologists in media archaeology are the media themselves - not mass media (the media of representation), but measuring media which are techically able to decipher physical signals, and representing them in graphic forms alternative to alphabetic writing since sound is articulation in time: the oscilloscope, or by numerical auralization.

Traditional archaeology - associated with digging artefacts from the past in sand and earth - is

[109] Mathias Fink, Time-reversed acoustics, in: Scientific American, November 1999, 91-97 (92)

[110] See Michael Darroch, Bridging Urban and Media Studies: Jaqueline Tyrwhitt and the *Eplorations* Group, 1951-1957, in: Canadian Journal of Communication, Bd. 33 (2008), 147-169 (156)

performed by humans. Let us rather focus on technologies themselves as new kind of archaeologists of acoustic and sonic phenomena. Electronic autopoiesis here becomes an argument: What has been electro-acoustically created, can be re-created by virtual archaeology, such as the *Virtual electronic poem* (an audiovisual 3-D projection) reconstructing Edgar Varèse's *poème électronique* installed once at the Brussels World Fair 1958 in the afterwards deconstructed pavillion designed by Le Corbusier and Xenakis.[111]

The immersive environment developed in The Virtual Electronic Poem makes the remarkable aspects of the Poème experience accessible again half a century after the event, thereby phenomenologically annihilating the difference in terms of time; the "historical" distance at least becomes mssively condensed. When it comes to recorded signals instead of printed alphabetic records from the past, re-play becomes possible by techno-mathematical means. What historical research demands here is a differentiation between reproduction, simulation and emulation as known in retro-computing.

Let us separate mere functional emulation from simulation which includes the precise micro-temporal characteristics or the original as well - which is crucial when it comes to reconstruct past sonospheres. Lowenthal terms *emulations* as "respectful yet creative reworkings of earlier forms and styles [that] transcend mere copying" and views an emulation of past artefacts as an on-going and evolving acticity that is always of its time but yet an essential original feature persists in all the variations and derivatives. "A reincarnating simulation seeks to bridge the ever changing gulf between past and present [...]."[112]

Archaic sonospheres

Is there an option to catch the authentic visual of sonic gesture previous to the age of technical recording media, the phonograph, the Welte-Mignon recording piano, and cinematography? The historical performance practice (for dance, theatre and music) can not only be reconstructed by scriptural sources, or indirectly by re-using ancient hardware - be it historical architecture, or historical music instruments[113]. The sonosphere itself waits to be re-sonified by acoustic archaeology.

Archaeoacustics and sonic archaeology as ways of making acoustic properties of the cultural past "understandable" have been established as proper academic disciplines by now. Past sonospheres ask for a media archaeology of the acoustic - with digital media themselves being the active archaeologist. Digital Signal Processing and computer-based tools like wave field synthesis (which media-archaeologically recaptures Christiaan Huyghens's approach to the

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[111] The *Virtual electronic poem* has been installed at Medienkunsthaus TESLA, Berlin, in January 2006

[112] Martin Campbell-Kelly, Past into Present: The EDSAC Simulator", in: Raúl Rojas / Ulf Hashagen (ed.), The First Computers. History and Architecture, Cambridge, Mass./ London (MIT Press) 2000, xxx-xxx (399), referring to: David Lowenthal, The past is a foreign country, Cambridge U.P. 1985, 301 <prüfen>

[113] See Peter Donhauser, Elektrische Klangmaschinen. Die Pionierzeit in Deutschland und Österreich, Wien - Köln - Weimar (Böhlau) 2007

nature of sound propagation) and other technical dispositives now allow for the virtual (which is: digitally computed) reconstruction of "historic" acoustic spaces.

One can only tentatively re-create the soundscape of past cities like Berlin around 1900. But by measuring remaining rooms by acoustic beams[114], one can digitally *render back* the acoustics of architectural spaces such as ancient Greek theatres.[115] Even if media-culturalized ears may have been *tuned* differently since, there is a acoustic tempor(e)alty which *endures* in Henri Bergson's sense. Once technically recorded, sound is eqipped with an "historical index" (Walter Benjamin's term) which transcends the purely historicist chronology. The positivist illusion of simulating past acoustic space is deferred by the more difficult task of reconstructing acoustic time: time-tuned sound. Such a sonosphere refers a) to the surrounding space and b) to the sources of sound, f. e. early music instruments.

Auralization of *Teatro Olimpico*, Vincenza

A test case for the epistemological gap which occurs between discovering the sonic dimension as new kind of historical source and its simulation is the reconstruction of the acoustic condition of Italian Renaissance theatres by auralization. This form of audio communication with the architectual past is no understanding in the hermeneutic sense, but first of all a co-original reset.

The Teatro Olimpico in Vicenza (opened in 1585) is preserved until today (even if not in the original condition) and are thus radically present (enduring) in terms of architecture to the contemporary spectator and listener. Still it is characterized by what by definition constitutes the past as archaeological site: the absence of humans - the audience which once filled the theatre in its performative meaning. The sonic retro-projection of listening subjects (receiver positions) based on impulse response measurements appropriate for auralization therefore is an additional virtual information. "Only an acoustical reconstruction of the historical conditions including the effect of the audience would give reliable evidence of the original performance conditions."[116] Acoustic information derived by measurement is archaeological evidence, but only by subsequent simulation of the occupied state this information turns into a "historical" one. If such auralization is computationally folded upon a reconstruction of the original theatre which itself is a computer model, a new kind of historical imagination emerges which transcends its data-archaeological source base. The epistemologically critical qualitative jump occurs exactly between the measurement of physically given spaces and the simulation of virtual sonospheres. Reverberation times for the unoccupied case of the theatres under analysis are derived from the measurement, while impressions for the occupied case are derived from the non-human, software-based simulation of human presence. Here, the differences between measuring of real conditions and simulations oscillate: empty room *versus* occupied condition (including a partial reconstructin of the historical state).

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[114] See the media art work *Echo Rotation* by Robert Schwarz and Emad Parandian, exposed at the Ars Electronica festival in Linz, Austria, September 2009

[115] On the "musical" tuning of ancient Greek theatre architecture, see François Canac, L'acoustique des théâtres antiques, Paris (Centre national de la recherche scientifique) 1967

[116] Weinzierl et al. 2014

Different from historical imagination which tends to fill the lacunae in the archived sources, a disciplinary virtue of archaeology is the transparency of uncertainties. An impulse response in the *Teatro Olimpico* for a central source and receiver position can be reproduced, but the simulation reaches its limits when it comes to correctly reproduce a cluster of simultaneously arriving reflections from complexly structured surfaces which in fact make the "historical" identity of the concrete room - the individual material fingerprint.

The Teatro Olimpico integrates elements known from Roman theatre design into a large and reverberant enclosed space. From the room acoustical measurements according to ISO 3382 a remarkable conclusion can be derived:

"With reverberation times of more than two seconds and speech transmission indices (STI) close to 0.5 even for the occupied condition, modern standards of theatre acoustics with their predominant focus on speech intelligiblity seem inappropriate for buildings of this period. Their acoustical properties along with their reception as documented by historical sources, instead, strongly supports the notion that theatres of the 16th and early 17th century have to be equally, if not primarily, considered as musical performance spaces. They represent the Renaissance concept of a theatre of antiquity to be reborn in buildings based on antiquity, and anticipate elements of the new genre of the opera emerging at the same historical point in time."[117]

The stratetic link between the auralization of the Palladio theatre in Vincenza and sonic media archaeology is in its "musical" conclusion: The mesaurements revealed the prevailance of the musical performance part in such Renaissance auditories which were closer to the ancient concept of the theatrical choir (and Monteverdi's early forms of opera) than to the speech-focused modern theatre.

In terms of speech transmission, the Vincenza theatre - concluding from the measurement results - seems deficient: "one could be tempted to consider the buildings as an acoustical failure, potentially due to a lack of experience in theatre design or a lack of room acoustical knowledge in general. This conclusion would, however, not take account of the cultural context." <Weinzierl et al. 2014>. This coupling of measurement data and its derivative simulation with the textual archive turns media-archaeological research into an historical argument. Respecting the numerous preserved reactions to the opening performance of *Edipo tiranno* in the Teatro Olimpico, all sources underline the positive overall impression of the performance space properties. "They also give evidence of the importance of the musical part of the theatrical performance" <Weinzierl et al. 2014> and its acousmatic effects, since the instrumental effects turned out from behind the stage. Whereas the the choir was acting on stage, the musical instruments were not located in the orchestra space in front of the stage, but inside the backstage scenery, providing for a soft and gentle sound. With respect to the instrumental parts, Angelo Ingegneri, stage director of the opening performance, reports that after the curtain had fallen to the ground in front of the stage, an instrumental and vocal music, the sweetest one may imagine, and at the same time equally soft, would begin to resonate from behind the stage. It appeared as if it would resonate "from far away".[118]

Here the new quality of supporting evidence prodvided by historical records is revealed by

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[117] Stefan Weinzierl, Paolo Sanvito, Frank Schultz and Clemens Büttner, The acoustics of Renaissance theatres in Italy, forthcoming in: Acta Acustica united with Acustica 2014 (Summary)

auralization - a research method which differs from the traditional text- or score-based archive: "The duration of the purely instrumental parts is unknown, since no score is preserved" <Weinzierl et al. 2014>.

Since the Teatro Olimpico stands for the idea of an ancient theatre to be literally reborn, the musical composition, with its predominant focus on text intellegibility and a subordination of instrumental parts, anticipates elements of the opera which emerged only a few years after the opening of the Olimpico such as known from Monteverdi. "That the Teatro Olimpico provided appropriate acoustical conditions for this new theatrical genre seems clearly confirmed both by contemporary reports and by the acoustical data of the current investigation" <Weinzierl et al. 2014> - thus mirroring re-enactment idea of "Renaissance" both in the macro-temporal (cultural history) and micro-temporal (auralizating) sense, short-cutting the "historical" distance.

Operative aurealization is able to "tunnel" the temporal difference which separates the present observer from the situation in the Renaissance past; a temporal *momentum* flashes which can not be grasped by macro-temporal concepts like "history" or sociological terms like "collective memory" any more, but rather constitutes a short-cut between present and past - a *resonating intervall* in terms of McLuhan who got this expression from Werner Heisenberg's quantum mechanics.[119] Computer-based acoustic modelling here acts as virtual archaeology, allowing for an acoustic time travelling. Next to simulating life and physics in laboratories as practiced in ninetheenth century science, the experimentalisation of the sonic past emerges.[120] This is my now means a metaphysical assumption, but based on the most physical techno-mathematical computation.

"Re-enactment" of past sonospheres (Collingwood)

The "musical" conclusion of both case studies in the exploration of past sonospheres leads to a final re-entry of the discussion of such operations for historical sources. Even for the most critical historian, musical temporality is of a specific nature which requires precise reconstruction of historical contexts but at the same time transcends the supposed historical distance which separates the present from the Renaissance past, as expressed in R. G. Collingwood's methodological *Idea of History*: "re-enactment". The sonic sphere allows for a temporal time-tunneling in a special way since it consists of time matter itself.

The rehearsal of a musical piece from the past transcends the unique location of its score in

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[118] As quoted <???> in: A. F. Gallo: La prima rappresentazione al Teatro Olimpico: con i progetti e le relazioni dei contemporanei. Edizioni Il Polifilo, Milan, 1973. See A. Ingegneri: Della poesia rappresentativa e del modo di rappresentare le favole sceniche. Ferrara: Baldini, 1598

[119] See Marshall McLuhan / Bruce R. Powers, The Global Village. Transformations in World Life and Media in the 21st Century, Oxford et al. (Oxford University Press) 1989

[120] See Martin Carlé, Geschenke der Musen im Streit ihrer Gehörigkeit. Die antike Musiknotation als Medium und Scheideweg der abendländischen Wissenschaft, in: MusikTheorie. Zeitschrift für Musikwissenschaft, vol. 22, no. 4 / 2007, 295-316 (313f)

archival time (what Walter Benjamin called "historical index"). Collingwood's notorious claim that historians have to "re-enact" the past event partly derives from his astonishment that a present performance of a musical piece composed at some earlier time can still be understood at all. This requires that the auditor performs it again in imagination.[121] Different from historical imagination in its literal visual sense, "the *sine qua non* of writing the history of past music is to have this past music *re-enacted in the present*"[122]. This practice of re-presencing (well known in its technological equivalent as hardware and software replication and emulation in Retro Computing culture today) escalated in audio recording media such as the phonograph. A gramophone disc, according to Günther Stern's (*alias* Günther Anders) habilitation thesis *The musical situation* (around 1930), does not reveal an acoustic image of the *Mondscheinsonate*, but the *Mondscheinsonate* itself[123] - just like the radio does not reproduce speech and music, but actually displays them (as argued by Theodor W. Adorno[124]). Auralization, in a further escalation of re-presencing the sonic past by algorithmic means, finally provides archival silence with sound.

Time-based signal processing media share with musical performances the power of generating the real-time affect of presence[125] - while at the same time undoing its transitive experience by the repeatability of any acoustic record. Sonic temporality thus turns into technical sonicity.

SOUND, SURVEILLANCE AND SIGNAL ANALYSIS. The other "Lautarchiv"

Techno-productive "operational" surveillance: The MfS "Stimmenarchiv"

Let us take the very name of the Berlin *Lautarchiv* in its literal meaning. German *Laut* is not the musical but the phonetic parameter of audio communication and therefore asks for signal analysis rather than for hermeneutics of cultural semantics. From a dialogue with the previous professor for linguistic forensics at the former section "Kriminalistik" of Humboldt University (Koristka), the hypothesis arose that recordings in the Sound Archive (the *Lautarchiv*) housed at my Institute might have been used for voice identification by the GDR State Security. It turned out from the files in the archives of the former MfS that Koristka's writings have been read as a central authority for voice recognition indeed,

and in 1985 an IT project called "Phonotek" (which refers both to the technologies of voice identification in the sense of „Phonotec“ and the audio archive in the sense of „Phonotheque“)

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[121] See William H. Dray, History as Re-Enactment: R. G. Collingwood's Idea of History, Oxford et al. (Oxford University Press) 1995

[122] Collingwood's 1928 lecture "Outlines of a Philosophy of History", published in: R. G. Collingwood, The Idea of History [*1946], rev. ed. Oxford et al. (Oxford University Press) 1993, 441

[123] As quoted in Reinhard Ellensohn, Der andere Anders. Günther Anders als Musikphilosoph, Frankfurt/M. (Peter Lang) 2008, 64

[124] In: Theodor W. Adorno, Current of Music. Elements of a Radio Theory [1940], hg. v. Robert Hullot-Kentor, Frankfurt/M. (Suhrkamp) 2006

[125] See Hans Ulrich Gumbrecht, Production of Presence. What meaning Cannot Convey, Stanford, Calif. (Stanfort UP) 2004

started systematic analysis "operativ-relevanter Sprecherstimmen"[126].

This sounds like a classical topic for archival research by historians, reconstructing the discursive, administrative and technical context.[127] The media-archaeological research track, though, has a decisively different emphasis; it does not focus in the ideological implications of acoustic sourveillance, but on the surplus in acoustic knowledge which actually arose from the application of voice-identifying technologies. In the former MfS, it has been the so-called "Technisch-Operativer Sektor" which developed or applied such tools. In a Foucauldean understanding, any paranoia (especially in agencies of state power) actually generates new methods and technologies of increasing knowledge. Media archaeology takes the very term "operative" (which is the key expression throughout almost all MfS files) in a productive sense: information provided by machines. Knowledge which results from techno-operative research is "timeless" beyond its limited historical or ideological discourse, since the language of what Nick Montfort la belled „technical report“[128] here deals with signal evidence rather than with semantic heuristics.

At the MfS, the term "operative" is not just an umbrella word for all kind of surveillance activities, but even technically tighly linked to the archive. A brochure on computing defines the Random Access Memory as such: "Arbeitsspeicher (auch: Hauptspeicher, Operativspeicher, Zentralspeicher) ist Bestandteil der Zentraleinheit einer Datenverarbeitungsanlge."[129]

Beyond ideological barriers in terms of cultural analysis and political correctness, there is a techno-formal language from the files which "speaks to us" in a non-historical way once our attention switches from the historian's to the media archaeologist's mood. In a remarkable document which deals with applications of psycho-acoustic science and signal acoustics (the

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[126] File MfS JHS [Juristische Hochschule Potsdam] 22035: Gärtner, Andreas, Die Bedeutung der Sprechererkennung nach meßtechnischen, hörtechnischen und operativen Faktoren bei der Bearbeitung der gegnerischen Geheimdienste und anderer relevanter Bereiche durch die HA III. Die Anwendbarkeit der meßtechnischen Faktoren einer Stimme als mögliche Recherchekriterien im Informationsgewinnungsprozeß, typescript, 18.3.1989, GVS [Geheime Verschlußsache] o026-344/89, JHS [Juristische Hochschule Potsdam] = Diploma, p. 8

[127] Karen Bijsterveld at Maastricht University) performs ongoing research on the Voice Archive (*Stimmenarchiv*) of the former Ministry of State Security (MfS) of ex-GDR

[128] Nick Montfort, Beyond the Journal and the Blog. The Technical Report for Communication in the Humanities, im *online*-Journal Amodern 1, Themenausgabe „The Future of the Scholarly Journal“ (2016): http://amodern.net/article/beyond-the-journal-and-the-blog-the-technical-report-for-communication-in-the-humanities/ (Abruf 11. Februar 2016)

[129] BStU, file MfS Abt. 26, Nr. 820: Broschüre (Druckschrift) *Technische Kommunikation. Überblick über wichtige Grundbegriffe der technischen Kommunikation (Computer, CAD/CAM, Telekommunkation)*, zusammengestellt von Hans Maschke, ed. by Zentralinstitut für sozialist. Wirtschaftsführung beim ZK d. SED, 2. überarb. Aufl. Berlin 1985 ("Nur für den Dienstgebrauch"), 28

polygraph) to speech identification, an epistemological rupture in the analysis of acoustic evidence is described: the human voice becomes subject of analysis in a double way: object of observation, but "subject" to machine listening. Understanding of human speech is no exclusive agency of human ears any more. The author, an MfS officer, makes use of the appropriate metapher of breaking through the "sonic wall".

["Eine wesentliche Seite der tschekistischen Theorie stellen all jene Erkenntnisse dar, die sich mit der Rolle des Menschen als Subjekt und Objekt der operativen Prozesse beschäftigen. Gleich, woher die Impulse aus diesem Teil der operativen Theorie kommen, ob aus der operativen Erfahrung <...> ob aus den Ergebnissen der Wissenschaften <...>."[130] And further: "<...> haben wir in der operativen Theorie vom Menschen eine 'Schallmauer' durchstoßen - so relativ das Bild auch für die Dimensionen unserer Arbeit sein mag."[131]]

Due to the abrupt ending of that German state, the administative files on voice recordings (*Stimmenarchiv*) in the archives of the former State Security of German Democratic Republic have survived and are immediately accessible in terms of academic textual research. But what about the technical accessability of the audio files themselves?

The challenge which arises from the actual telephone voice recordings by former GDR State Security is not the obsolete hardware to read magnetic data.

At the archives of the former State Security of German Democratic Republic[132], there is a special department for recovering ("Erschließung") machine-readable data from obsolete magnetic storage discs, headed by Stephan Konopatzky who has asked the Signal Laboratory of Humboldt University Media Studies for help in retro-computing the data hidden on large antique magnetic recording hard drives. In its last decade, GRD State Security increasingly had changed from type-written to computational data processing indeed.

The cassette tapes remaining from the so-called "voice archive" ("Stimmenarchiv") is analog audio signals which can still be accessed by any commerical tape deck. This is voices in rather technical than traditionally archival latency which, as long as they require electro-magnetical transduction for re-play, can first of all (i. e. on the media-archaeological level) be "heard" by machines only.

[When the pick-up transduces phonograpic grooves from mechanical "inscription" of physical sound into electro-magnetic current, is this "listening"?

The GDR State Security's definition for "Speaker archives" (*Sprecherarchiv*) was storage and retrieval systems for audio tapes on the basis of what was called "operative data" on the one hand and "speaker-typical characteristics" on the other.

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[130] File MfS JHS No. 165 "Gutachten zu den Forschungsergebnissen <...> 'Die wissenschaftliche Bewertung des psychophysiologischen Verfahrens der Stimmanalyse, seine Einsatzmöglichkeiten - Grundsätze in der politisch-operativen Aufklärungsarbeit des MfS' (vorgelegt von Oberstleutnant Roitzsch und Hauptmann Lips)". Typescript, p. 3 (signed: "Scharbert, Oberst", Potsdam, 2nd October 1979, Juristische Hochschule Potsdam) <= BStU Bl. 32>

[131] Typescript p. 5 <= BStU Bl. 34>

[132] Der Bundesbeauftragte für die Stasi-Unterlagen (BStU) in Berlin

["Sprecherarchive sind rechnergestütze Speicher- und Recherchesysteme, die auf der Grundlage operativer Daten und Sprechertypischer Merkmale arbeiten."[133]]

Nowadays, many automated search operations in news broadcast archives, f. e., are rather based on the speech recognition of the clippages, searching for key-words. The core media-archaeological research question is this: What difference did and still *does* it make if the administration and retrieval of analog voice recordings is not only computer-aided (that is, on the level of metadata), but the audio recordings themselves transform *from signals to data* by digital sampling? Then *signal* recording transforms into *information* storage.

The term used in our conference title is "sound data"; let us rather make a difference between *collections of phonographic analog audio signals* and *digital storage of sonic data*, since this difference is an essential change of medium state.

At the moment of the break-down of the GDR State Security in autumn 1989, surveillance of telephone voices had reached the point of changing from human identification of recorded voices (supplied by computer-based meta-data retrieval) to the application of fully *algorithmic* software for automatic voice recognition - which would created a completely different kind of "archive".

["Und es ist bereits abzusehen, wann Sonogramme" <sic> auch zum computergesteuerten Sprachvergleich im öffentlichen Telefonnetz gespeichert werden können. Der ehemalige BKA-Präsident Horst Herold malte <...> aus, daß Computer in der Lage sein werden, Inforemationen wie mit den Sinnen eines Menschen zu erfassen. Dann, gegen Ende des Jahrzehnts, könne es technisch möglich werden, die Fahndung nach gesuchten Straftätern unmittelbar auf Maschine zu übertragen."[134]]

A special task force investigated options of the application of computing algorithms for automatic voice identification; here computational intelligence and secret „intelligence service“ converge. One report insists on the remaining, unbridgable gap between human hearing ("Höranalyse") for issues which require *semantic* understanding, and analysis by sonagraphic *audio-signal* processing. Such "Meßanalyse" enables *differential* realtime voice identification, by comparing the signal output to similar recording evidence - which is the functional "archive", the *Sprecherarchiv*.

Once more the name Koristka turns up which has been the academic mastermind behind such reasoning on acoustics. Among the MfS files figures a copy of Koristika's article on forensic voice analysis.[135] Koristka himself wrote his habilitation with Horst Völz on the forensic use of

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[133] File MfS BdL No. 273 , letter (typescript) from 16th November 1989, concept by the Operativ-Technischer Sektor [BStU archival page no. 3-5]: *Dienstliche Bestimmung zur künftigen Arbeit mit Sprecherarchiven im MfS* (November 1989)

[134] Typescript Gärtner 1989, p. 57 (BStU p. 57), quote from West German journal *Der Spiegel* (No. 26, 23 June, 1986)

[135] Christian Koristka, Stimmanalysen - eine neue Methode der kriminalistischen Personenidentifizierung, in: Forschungen und Fortschritte, 41. Jg. <year ???>, Heft 10, 310-316, in: File MfS Abt. 26, Nr. 820

magnetic tape recording: "Im Speicherzustand erreicht die 'aufgenommene' Information gewissermaßen statische Eigenschaften, die verschiedentlich auch durch die Bezeichnung 'eingefrorene Information' charakterisiert werden."[136] .Koristka refers to L. G. Kersta's report on "Voiceprint Identification", in: Nature 196 (1962), 1253 ff. but differentiates the fingerprint as "direktes objektives Abbild" from the more contingent external conditions which envelop the recorded voiceprint <314>. Koristka defines the human Hearing Analysis (*Höranalyse*) as "subjective method", and the Measuring Analysis as "objective" <313>.

An expert report on voice analysis defends the *Höranalyse*, since such heuristic *resonance* only results from empathetic listening.[137]

As has been argued in Licklider's seminal article on "Human Machine Symbiosis" in 1960, it is the differential combination of the "narrow band", but parallel signal processing human brain with the accuracy of the digital, though sequential computer which results in most efficient human-machine communication.[138]

But even voice sonagrams only serve for an intuitive first interpretation; future voice identification will be data (rather than signal) based, allowing for "automatic analysis" <Koristka: 316>. In this algorithmic approach, surveillance practice and recent methods called "Digital Humanities" converge in media ethically ambivalent, through knowledge-generating alliance.

There is a temporal gap in the correlation between an actual voice recording with a signal from the *Stimmenarchiv*. In remarkable clarity - after removing circumstantial noise in the recording media and in background acoustics - an individual voice stays invariant against delay on the time axis[139], and its acoustic-phonetical characteristics are robust even against the speaker's intentional dissimulation.[140] This became media-theatrical drama in Samuel Becket's one-act

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[136]Christian Koristka, Magnettonaufzeichnungen und kriminalistische Praxis, Berlin (Ost) (Ministerium des Innern, Publikationabteilung) 1968, 24

[137]"Kein Analysegerät ist in der Lage, die subjektiven Einschätzungen von solchen Paramtersn wie Gesamteindruck, stimmfülle, Klangfarbe usw. in objektiven Tatbeständen vorzunehmen und darzustellen." File MfS - HA XXII, Nr. 17247, typescript "Planaufgabe 2051. Thema: Konzeption für die Schulung von Mitarbeitern operativer Diensteinheiten zur sachkundigen Beschaffung von Ausgangs- und Vergleichsmaterial für die Personenidentifizierung anhan dder Stimme und Sprache", chapt. "Meßanalyse", p. 243

[138]J. C. R., Licklider, Man-Computer Symbiosis, in: IRE Transactions on Human Factors in Electronics. HFE-1 (März 1960) No. 1, 4-10

[139]See Fig. 3 "Relative Übereinstimmung der Ausgangsinformation (AI) und der Vergleichsinformation (VI) des Stimmspektrums einer Person, die über Telefon gesprochen hatte <...>. Zeitspanne der Aufnahme der AI und der VI 12 Wochen", in: Christian Koristka, Die Verwendung der menschlichen Stimme zur Identifizierung einer Person, in: Forum der Kriminalistik 1 (1965), Heft 3, 32-36 (34)

[140] Gerhard van der Giet / Hermann J. Künzel (Bundeskriminalamt Wiesbaden) "Rechnergestützter Stimmenvergleich für forensische Anwendungen", in: Kriminalistik 9/81, 341-346 (345)

play *Krapp's last tape* from 1959.

[Hintergrundgeräusche und Störungen im Übertragungskanal (Mikrophon, Raumakustik) fordern automatische Spracherkennung heraus, während das menschliche Gehör in hohem Maße daraus zu filtern vermag (siehe Cocktail-Party-Effect, spektrale Verdeckungseffekte, neuronale Kurzzeitadaption, Refraktärzeiten und die von Jonathan Sterne beschriebenen Verfahren der MP3-Kompression). Die Autoren entwickeln daher ein Verfahren zur Verarbeitung von Sprachsignalen für einen Hidden-Markov-Spracherkenner nach dem Modell (als Simulation) der menschlichen Gehörperipherie. "Das auditorische Modell erzeugt eine interne Repräsentation des Sprachschalls, welche dem nachgeschalteten Erkenner als Eingang dient."[141] "Hidden-Markov-Modelle (HMM) haben das Ziel, ein statistisches Modell zur Beschreibung der Auftretenswarscheinlichkeit von Vektorfolgen aufzubauen und seine Parameter zu bestimmen."[142]]

Especially in the case of radio archives, the tapes preserved by the sender significantly differ in quality from the sound quality actually received (and occasionally recorded on magnetic tape by amateurs) in concrete radio sets, esp. in the case of international radio via short wave transmission.

The focus on the message of sound archives as technical medium significantly differs from the focus on the cultural "content" of such sound recordings. Is the historical reading an "othering" (Vivian Sobchack[143]) or even obscuration of the arte-factual sound archive by the discourse of political correctness?

A document from 1988 in file MfS OTS No. 1635, differentiates between "Auditive und messanalytische Parameter zur Sprecherklassifikation" - which is human *listening* (performance) vs. non-human signal recognition (operative); another file <MfS Abt. 26 Nr. 790: page no. 38 / 39> explicitely differentiates between "Höranalyse" (human listening) and "Meßanalyse" (machine measuring of the physcial articulation) by sonography; both methods are explicitely put into a complementary (if not even "dialectic") relation.[144] In addition to this channel of transmission, possible technical noise sources are taken into account.[145]

„Listening“ *without* the human ear leads to a different kind of sonic hermeneutics, a differnt kind of understanding. Machines do not "hear" language but measure audio signals - which is its weakness and strenght. They have a different insight into sound and voice recording, exactly because they do not "listen" but radically analyze.

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[141] J. Tchorz / T. Dau / B. Kollmeier, Gehörtgerechte Signalvorverarbeitung zur robusten Spracherkennung in Störgeräuschen, in: Dieter Mehnert, Historische Schallaufnahmen. Das Lautarchiv an der Humboldt-Universität zu Berlin, in: same author. (ed.), Elektronische Sprachsignalverarbeitung, Dresden (Ges. für Signalverarbeitung und Mustererkennung) 1996, 46-51 (46, *abstract*)

[142] Ch.-M. Westendorf, Experimentelle Sprachverarbeitung mit signaLab, in: Mehnert (Hg.) 1996: 76-85 (82)

[143] Sobchack 2011, "Afterword"

[144] Archival page no. 50 / no. 51 on auditory analysis by sonagraphy

[145] Archival page no. 45 / 46 on possible technical signal disturbance

This is in full accordance with Mara Mill's findings on previous physiognomic uses of sound recordings which resulted in the development of machinic speech recognition.

"Collections of phonographic 'vocal portraits' - such as the recordings of 'criminal' speech in Berlin's Lautarchiv - prompted investigations into the features of the individual voice, for the purposes of characterology, lie detection, and speaker identification. Visual recordings of speech (oscillograms and spectrograms) were at first applied to the same purposes. Voiceprint identification" was eventually abandoned as hopelessly inexact, but the generic speech features described in the era of Stimmphysiognomik subsequently enabled the beginnings of speech recognition by machine."[146]

Ironically, machine-based voice surveillance results in tools which can now be applied for scientific research of sound archival heritage as well. Surveillance and research are two sides of one algorithmic coin in audio signal processing.

Historians tend to read archival files on the application of speech analysis tools by former GDR State Security in their political context which has been a totalitarian state. While our conference *Listening to the Archive* is sub-titled "Histories of Sound Data in the Humanities and Sciences", let me replace "histories" by archaeology.

The decipherment of audio records not as „historical" documents but as sonic monuments with media-archaeological interest rather asks: To what degree did (and still does) surveillance paranoia result in analytic technologies which actually create knowledge?

The MfS "Speech archive" project raises the question: To what degree does inhuman listening provide insight which is otherwise hidden by sympathetic human listening to the archival voices? Paranoia, as we learned by Michel Foucault, does not only lead to a suppressive power regime, but is productive for knowledge as well.

So why not use the clever algorithms applied by MfS or NSA for voice recognition since the 1950 on computational basis for cultural analysis? Or does this rather degrade "digital" humanities to a second-hand justification and ornament of non-academic practices? Would it be naive to apply algorithmic tools for scientific research without being aware that such tools have been developed for forensic, surveillance or military application (as "Heeresgerät" in the Kittlerean sense)? Is there a "good" cultural use of "evil media"?

"Cold listening" to sensitive sound archives

Such "cold listening" that uses speech features automatically extracted by computer algorithms, today, results in experimental sonifications of large sound collections.

[For a computer, a sound file is only an array of binaries.
A computer uses "low-level" information to "interpret" the sound. A semantic gap opens when it comes to "understand" the musicality of such audio signals. Trying to "close the semantic gap" <...> is one of the motivations for using multiple features", such as detecting similarities

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[146] *Vocal Features: From Stimmphysiognomik to Speech Recognition by Machine. The physiognomic uses of sound recordings between 1926 and 1953*, abstract

in sound files. We learn the formal way of "hearing" from algorithms whicih identify what a sound represents.]

Lev Manovich's software mining of big data explicitely adapts Franco Moretti's approach to hundreds of literary texts from past centuries, requiring "distant reading". What Manovich has developed in his so-caled "cultural analytics", though, is focused on visualization.[147]

"Sensualizing" high-dimensional data does not necessarily require diagrammatic visualization, but rather aks for ways of sonic "algorhythmization"[148].

This may be modified for acoustic space, to "distant hearing". Most digital analysis of files from sound archives is still restricted to one piece, but large-scale digitisation projects open the option for "big sonic data" analysis.

The true impact of digitisation is the message of algorithmic computing as medium. The application of sonic data mining un-covers hidden, archivally implicit knowledge which musicological research would not even ask for. Mathematical intelligence of algorithms serves for developing new strategies of audio archival findings like so-called "deep machine learning" - a set of algorithms which uses a deep graph with multiple processing layers for automated speaker and speech recognition.[149] Whith the "deep" suggesting a stratigraphic layers, it is still not an archaeological metaphor but a pointer to the radical way of *operative* Archaeology of Knowledge (Foucault) which is the implementation of advanced mathematics in high-frequency computing power: media archaeology as techno-mathematical alliance.

While musicological understanding re-creates cultural memories which are clearly addressed to the human ear, algorithmic sonic data mining provides insight into *implicit sonicity*.

Archivological analysis is using such software tools not for individual sound recordings but for a large, trans-individual array of sound files.

In the 20th century, listeners to phonographic archives typically
compared small numbers of sound records, "and the use of our human cognitive capacities unaided by machines was considered to be sufficient. Even if the number of phonographic and gramophonic records in sound collections like the Lautarchiv looks impressive and therefore has been rather individually researched so far[150], it is small when compared to born-digital sound files around the globe today. This has resulted in the development of a kind of mass-statistical ear. In social web portals like YouTube, tens of thousands of files with sonic expression are born digital as user generated content which poses a different challenge to individual human research by its shere scale. Even "digitized collections of historical artifacts can be also quite large"[151].

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[147] See Lev Manovich, Data Science and Computational Art History, in: International Journal for Digital Art History, no. 1 (2015), 12-35

[148] In the sense of Shinatoro Miyazaki, xxx

[149] As deeply described in the Wikipedia entry *online* (accessed July 19th, 2016)

[150] See Nepomuk Riva (ed.), Klänge aus der Vergangenheit, xxx

[151] Manovich 2015: 33

In a paraphrase of Lev Manovich's term for computer-based "cultural analytics", there is now the option to apply computational, which is: algorithmic intelligence ("intelligence" in both its meanings). "Listening to the digitized sound archive" in contemporary culture not only offers but even requires the usage of information science.

But at that point of analysis, "algorithmic criticism" is required.[152] The real sound archive is not its recordings but the *archive* in Foucault's sense: the underlying algorithms of digital audio signal processing tools themselves.

Key methods applied here are core opeations of data science such as feature extraction, measuring distance in feature time, and dimension reduction.

Oral testimony from Holocaust survivors (like the Yale Archive), out of necessity (the material deterioration of the magnetic tapes), has been digitized. The audio tracks can be extacted and used as data bank for new algorithmic creation of so far hidden knowledge. A proposal by Amit Pinchevski, media scholar at the Department of Communication of Hebrew University in Jerusalem, calls for an experimental data mining of Holocaust testimony. If all these voices are thrown - contrary to their hyper-individualization - into one data pool and tumbled algorithmically, step by step, out of the phonetic chaos patterns will emerge like in a minimal music composition by Steve Reich (phase shifting / "phrase shifting"): syntactic formulars and repetitive expressions. It will become apparant to what degree the oral history interview dispositive already creates narrative conventions which are sublimanlly at work even if the actual recollection is the most dramatic individual experience.

There is a specific reason why I refer to Steve Reich's musical composition *Piano Phase*, since the same composer created the piece *Different Trains* where he correlated phonetic parts of oral testimony of former American train porters to "different" train sounds before, during, and after World War II.

What if that "other listener" is non-human, in fact: a techno-mathematical ear? If such an active computer-graphical diagramm is developed in the Signal Laboratory for opening up the Phonogrammarchiv and the Lautarchiv to so-called Digital Humanities - even at the risk that this might end up in algorithmic inhumanity. What if not humans but algorithms "listen" to the recorded voices? Does the "cold ear" of media archaeological *listening to the archive* correspond with the telephone voice surveillance practice of former GDR State Security? Here a critical question arises. Does the active application of "digital humanities" tools to audio collections like the Lautarchiv with recordings from World War I, or to oral history projects of former Jewish prisoners in German camps immediately after World War II such as David Boder's wire recorded narratives in Displaced Persons Camps in 1946[153], or the Yale Video Archive for Holocaust Testimonies. Videotaping Holocaust survivors here began in 1979, later named the Fortunoff Archive, resulting in today more than 4400 testimonies and some ten thousand hours of video, or finally, the "Stimmarchiv" of the State Security of former GDR, miss the ethically "sensitive" issues of such archives?

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[152] See Stephen Ramsay, Reading Machines. Towards an Algorithmic Criticism, Urbana, Chic. (Univ. of Illinois Pr.) 2011, Kap. 1 "An Algorithmic Criticism", 1-17

[153] See Alan Rosen, The Wonder of Their Voices: The 1946 Holocaust Interviews of David Boder, Oxford (Oxford UP) 2010

What happens if a collection of individual voices (be it the voice of Max Planck in the Lautarchiv, or Holocaust survivors) is transformed into big data? Is the ethic momentum of historically "sensitive archives" lost by sonic data mining?

The original recording, archiving, and dissemination of video testimony may have been widely defined through an ethics of listening. With the listener being replaced by software for audio data mining, does this ethical dimension get lost in favor of a non-human analysis of testimony?[154]

Turning speech evidence into data is the opposite of the use of figurative description "adding to the factual reality of the audio signal as acoustic event; data analytics rather "subtracts from, or abstracts of the narrative as told by the human testimonies.

Algorithmic analytics shall not aim at creating narrative relations between data banks but rather signal correlation which pays attention to the subliminal tonal gestures.

"Cantometrics"

The plea for sonic knowledge necessarily leads to a critique of (re-)visualizing the sonic archive by software tools like "Sonic Visualizer", e. g. in computational ethno-musicology.[155]

Automated feature description as a media-archaeological tool is close to the methods of Systematic Musicology: "<...> large electronic collections of music in a symbolically-encoded form <...> have enabled music researchers to develop and test <...> empirical theories of music on large data sets." The availability of such music data "creates a new perspective for Systematic Musicology, which <...> often sets out to explain or describe music through the induction of empirical laws, regularities or statistical correlations in relation to music objects or music related behaviour"[156] - such as the servo-motoric feedback between the *guslar* singer and his string instrument, the *gusla*.

For the M⁴S project (Modelling Music Memory and the Perception of Melodic Similarity), hosted by the Computing Department of Goldsmith's College (University of London), the term "symbolically-encoded music" means "<...> music in a computer-readable format where the

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[154] See Todd Presner, The Ethics of the Algorithm: Close and Distant Listening to the Shoah Foundation Visual History Archive, typescript, 17 = draft March 2012; *online* http://www.toddpresner.com/wp-content/uploads/2012/09/Presner_Ethics.pdf

[155] See xxx Svec, Lomax' Deep Digitality, in: xxx; Rainer Kluge's thesis (Dissertation B) at Humboldt-University Berlin *"Faktorenanalytische Typenbestimmung" als Beispiel des Rechnereinsatzes in der systematischen Musikwissenschaft*; George Tzanetakis et al., Computational Ethnomusicology, in: Journal of Interdisciplinary Music Studies, Fall 2007, vol. 1, issue 2, 1-24

[156] Daniel Müllensiefen / Geraint Wiggins / David Lewis, High-level feature descriptors and corpus-based musicology: Techniques for modelling music cognition, in: Systematic and Comparative Musicology: Concepts, Methods, Findings, edited by Albrecht Schneider, Frankfurt (at Main) et al. (Peter Lang) 2008 (Hamburger Jahrbuch für Musikwissenschaft, vol. 24), 133-153

fundamental unit of representation is the note."[157]

"Symbolic formats can be contrasted with audio formats which, instead of capturing notes explicitly, encode the sonic aspect of a musical performance by representing sound as a complex waveform. The best known formats are audio CD, the WAV and AIFF formats used primarily in computers and iPods, and MPEG-1 Audio-Layer 3 (mp3) as a compression format used for web-based and portable applications."[158]

The "semantic" listening (concentrating on *musical objects* like a melody) makes the difference to the media-archaeological "(h)ear(ing)" which focuses on the *sonic object*. Whereby a melody is basically a contour kept and recognized in memory "over time" (in both senses), the time-critical approach of media archaeology rathers concentrates on non-harmonic micro-figurations of temporality within the sonic event. Thus special algorithms are needed which identify such temporal qualities (such as dynamic time warping[159]), and efficient algorithms "for extracting the repetitive structure of an audio recording"[160].

"The most ambitious corpus-based musicology project was one based in Princeton University concerned with Josquin scholarship. From 1963 to the beginning of the eighties, researchers, led by Arthur Mendel and Lewis Lockwood, generated electronic scholarly editions of the complete works of Josquin <...>, many including concordances, and relevant related works. From this, statistics for cadential progressions and modal indicators were compiled and subjected to statistical analysis primarily in order to study issues of authorship and stemmatic filiation (see <...> various papers in Computers in the Humanities between 1969 and 1978). The ambitions of this project, though great, never extended to revealing cognitive processes, being limited, essentially, to style analysis."[161]

"In folk music research, feature extraction and the use of computers have been employed as a means for the (automatic) classification of songs (mainly melodies) according to their musical characteristics. In a comprehensive study Steinbeck (1982) classified European folk melodies into six homogeneous groups by employing Ward’s classification algorithm with 35 relatively simple features derived from the monophonic melodies. He was able to show that this classification was in close correspondence with
the melodies’ regional origin and functional uses."[162]

At the borderlines of the *semantic gap*, to most musicologists "the evaluation of musical relationships is not a task amenable to automation. The quantification discussed above is a statistical one and, whilst its usefulness will be greater as more information is provided to the system, it is cognitive experiment and musicological reasoning that must prove the final arbiter of the system’s performance. Furthermore, such an approach can only offer limited

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[157] Müllensiefen / Wiggins / Lewis 2008: 133

[158] Müllensiefen / Wiggins / Lewis 2008: 133

[159] See Müller 2007: 69

[160] Meinard Müller, Information Retrieval for Music and Motion, Berlin / Heidelberg / New York (Springer) 2007, 165

[161] Muellensiefen et al.: 136

[162] Muellensiefen et al.: 136

assistance to those wishing to perform detailed analyses of single works—which is the standard paradigm in traditional music analysis."[163]

"The power of the quantitative <...> lies in the new kinds of access to interpretation it provides." *Distant hearing* (as slighty modified in respect to Fitzpatrick's review of Moretti's approach) inevitably raises the question not of *whether* one ought to hear distantly, but of *what* one can hear *only* distantly, and what one requires closeness in order to capture.

But while such an analysis focuses on an individual song recording (which can be "big data" in itself, for hour-long oral poetry performances like the *guslari* performances in Bosnia and Montenegro in the tradition of Homeric epics, stochastic signal analysis covers "big data" of a whole sound archive.

A non-historicist approach to sound archives takes its point of departure from the recorded signals themselves which stay invariant towards the passing and changing historical and cultural contexts happening in the temporal progress around the durable material record. Cultural contexts change, while the physical laws of speech articulation and recording change according to a different temporal rhythm which is not historical time.

- Sound archives are "sensitive" not only in ethical and other meaning but in being non-symbolical, non-alphabetical: signals are the most indexical "sensitive" traces of physical, here: acoustic events.

- A new option of audio signal mining opens when the term "digitizing" analogue sound carriers is not simply understood as an act of saving recordings and making them able for "open access". The real opening of access is the use of audio data in terms of mathematical intelligence.

The digitization of analogue sound signals is not a re-alphabetization of music, but its mathematization. Different from classical computational linguistics, algorithms themselves become the non-human agencies of knowledge. This starts with simple analytic tools like the "Silence Finder" in the free audio software Audacity.

In algorithmic techno-memory practice, the "Silence finder automatically, that is: algorithmically, taggs intentional and non-intentional pauses in speech or sound files.

Even if this tools has been developed for sound editing and opens the option of "remove" the moments of silence, it can be used as a research tool to identify in large data banks the moments when enunciation hesitates - for reasons which then require hermeneutic, i. e. human, context-intense interpretation.

Is there a "sound of the archive"?

"Listening" to the archive?

There is a discursive (cultural historical) listening vs. the audio-listening, as is evident from the present conference papers which fall into two groups: one performs "close listening" to the

[163] Muellensiefen et al.: 139

materiality of both sound and its recording technologies, and the other de-centers such non-discursive practices by widening the scope of analysis in cultural and historical (text-based) contextualisation. There are "two bodies" of the archives here: the real sound archive, and the historical archive of which the sound archive is not an active agency but an object of research.

Different from the archive as symbolic order composed of records in historiographic, that is: in alphabetic notation, there is an para-archival modality of sub-textual, signal-based recording of the past: the sound of times past. The BBC World Service has launched the "Save our Sounds" project, looking to "archivize" sounds that may soon be lost due to the post-industrial world.[164]

Silence itself can become part of the archive. The software for sound analysis *Audacity* actually provides an algorithm called "Silence Finder". The shere endurance of periodic frequencies is a Bergsonean time which passes. While an empty space within a painting positively endures with time, silence in acoustics is always a temporal (though negative) event itself which I call its "sonicity". This term reminds of the fact that explicit sound is just a thin slice of a wider spectrum which is audible to humans. But below and beyond this phenomenological range, sonicity mediua-epistemologically refers to implicit sound as an object of knowledge about temporal forms of the vibrational event, to time signals as such.[165]

Historians remind us that there is no unmediated access to the past. But in the negative sound of the archive, its silence, we listen to the past in its truest articulation. Let us pay respect to absence instead of converting it into the specters of a false memory. Written records or printed texts necessarily miss sound matter. But in the deeper sense there is implicit sonicity even in images, diagrams and graphs which are derived from sound sources; any sonagram keeps an indexical relation to the sonic event.

There is sound even from the digital archive. When an ancient "Datassette" is being loaded from external tape memory into the ROM of a Commodore 64 computer, we are actually listening to data music. What we hear is not sound as memory content like an old percussion-assisted song[166], but rather the sound of computer memory itself, that is: a software program which is "scripture" (though in the alphanumeric mode). We are listening to the data archive which is not sonic memory but sonicity.

Audio-recordings and their media-archaeological understanding

Dis-covering the temporal implications (rather than metaphorical "layers") of the archive is not just an operation of the mind or the eyes, but of hearing and literally archival "understanding"

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[164]But caution, this is not an archive: As long as an algorithm is missing which rules the transition of sound provenience to permanent storage, it is just an idiosyncratic random collection.

[165] For a related approach see Steve Goodman, The Ontology of Vibrational Force, in: same author, Sonic Warfare. Sound, Affect and the Ecology of Fear, Cambridge, Mass. (MIT Press) 2009, 81 ff., and Peter Price, Resonance. Philosophy for Sonic Art, New York / Dresden (Atropos Press) 2011

[166] For an analysis of the interplay between technical memory and affective remembrance see Ben Anderson, Recorded music and practices of remembering, in: Social and Cultural Geography, vol. 5, No. 1, March 2004, 3-19

as well (German *verstehen* refers to auditory as well as to cognitive perception).

The spatial, text-based archive is familiar as a radically silent place. Acoustically, this silence might be re-interpreted as an enduring negation of time-based sound, as performed in John Cage's piece *4'33*.[167] Whereas the-classical archive which is based on alphabetic scripture is a static array of records (like parchments and papers) on the grand scale and letters on the microscale, which can be set into motion only by the act of human reading line by line, the Edison phonograph at first glance looks like the first form of "archive in motion", since its "records" (notably the early ethnographic field recordings around 1900, leading to the Vienna Phonograph Archive and the Berlin Phonogramm Archive) are based on a continuously rotating, technically moving apparatus both in recording and in re-play.

Strictly speaking, the phonographic record which consists of intinitesimally continuous signals instead of alphabetic or other elementary symbols is no "archive" at all - with the archive being both composed of and itself representing the symbolical order of discrete elements (letters on the lower level, archival tectonics on the upper oganizational level). Phonographic inscription is different from cinematographical recording and projection of visual momevent which is based in discrete, mechanically interrupted frames.

When listening to an ancient phonographic record, *the audible past* (alluding to Jonathan Sterne's book title) very often refers rather to the noise of the recording device (the ancient wax cylinder) than the recorded voice or music. Here, the medium talks both on the level of enunciation and of reference. What do we hear most: the cultural content (the formerly recorded songs) or the medium message such as limitations in vocal bandwith, even noise (the wax cylinder scratch and groove)?

With digital sampling and processing of audio-signals, analog noise is usually significantly filtered, thus: silenced. But the former noise is being replaced by an even more endangering challenge: the "quantizing noise" on the very bit-critical (technical) level of signal sampling, and the migration problems of digital media data and the physical vulnerability of electronic storage media in terms of institutional (cultural) sound tradition. This is not just a technical question, it has an epistemological dimension as well.[168]

"Forensic" signal (instead of textual) criticism: First audio recordings

In common history of technology, the first melodic voice recording is supposed to be the childen song "Mary had a little lamb" as performed by Thomas Alva Edison himself on his tin-foil phonograph in 1877.

But caution, *arché* (the core term in the notion of media archaeology) does not primarily denotate a beginning in the history of technologies but rather a governing principle. Indeed the earliest sound recording has been preserved (in Johann Gustav Droysen's sense) as relic („Überrest“), as phonogram which was never intended to be re-played: Édouard-Léon Scott de Martinville's notational traces of acoustic vibrations produced by his "Phonautographe" on a rotating cylinder, produced for phonetic analysis. Only media-active, non-human archaeology,

[167] On the occasions which led to this composition see Seth Kim-Cohen, In the Blink of an Ear, New York (Continuum) 2009, 160 ff.

[168] See Arild Fetveit, Medium-Specific Noise, in: Liv Hausken (ed.), 189-215

that is: with technologies themselves as archaologist like the „virtual stylus“ (or the „variable width“ technology), opens this silent archive of sound in order to let is resonate again.

[Foucault's archaeology silences talkative historical narratives: "history, in its traditional form, undertook to <...> lend speech to those traces which, in themselves, are / often not verbal, or which say in silence something other than what they actually say; in our time, history is that which transforms *documents into monuments.*[169]]

[The (re-)sonification of the phonautographic sound recordings has been achieved by the First Sound Initiative cofounder Patrick Feaster (Indiana University) and by the radio historian David Giovannoni.[170]]

Not by coincidence, one of the earliest of these recordings which Scott deposited at the French Institut National de la Propriété Industriel in 1859 is a media-archaeological sound indeed, originating from a measuring tool: a tuning folk vibrating at 435 Hertz (at that time adopted as the official French reference pitch for musical performance).

It is a hybrid technology of sound re-synthetisation which made these oscillation curves vibrate again: optical scanning of acoustic signal lines (as known from sound film for ages). All of the sudden, once more a children song re-sonates: "Au clair de la lune, Pierrot répondit“, 8. April 1860, Paris.[171]

What looks like the pick-up of sound images by a "virtual digital gramophone needle"[172], is indeed a registration of a new kind: digital, time-discrete sampling and mathematical quantization.

Only mathematized media technology can trace and re-veal such a sonic knowledge *(mathesis*) which leads to an extended notion of the text-critical method as known from the philological disciplines so far - towards a veritable signal critique which is no more exclusively performed by human scholars but as well (and even more) by the measuring media and their implemented algorithms themselves.[173]

[To give another example: The ealiest known sound recording in Norway has been produced on February 5, 1879, by an Edison tin-foil phonograph in Kristiania (the previous name of Oslo). The tradesman of musical scores Peter Larsen Dieseth is supposed to have sung a liturgic psalm. In 1934 Dieseth presented the Norwegean Museum of Science and Technology a phonographic tin-foil which was flattened and glued on a piece of paper and enclosed by a picture frame; since then the artefact hang silently at one of the museum walls (the most secret and silent archives are the sound archives). Next to the tin-foil piece Dieseth had

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[169] Michel Foucault, Archaeology of Knowledge, transl. A. M. Sheridan Smith [*1972], London / New York (Routledge Classics) 2002, "Introduction", 3-19 (7)

[170] See http://www.firstsounds.org

[171] *online* http://www.firstsounds.org/sounds/1860-Scott-Au-Claire-de-la-Lune-09-08.mp3

[172] Harald Haack, Die erste Klangaufzeichnung. Eine Audiografie, *online* http://newsbattery.blogsport.de/2008/05/07/die-erste-klangaufzeichnung-eine-audiografie

[173] On forms of media-archaeologically augmented textual criticism see Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008

manually written that this was the original of the earliest sound recording; all the evidence thus is a tinfoil flattened to a "document" and annotated by a remark by its former collector. This resulted in the first officially archivized record of sound in Norway. The recording itself remained un-playable.]

In a joint project the Norwegean Museum of Technology (Oslo) and the National Library started the effort to dis-cover the auditive content from this artefact, by applying the method of non-invasive, touchless optical scanning (as developed by the School of Engineering Sciences at the University of Southhampton). By means of optical scanning of signals and application of digital filters, it is possible to digitally trace past acoustic signals from such records. From such an operation we expect sound. The digital "reading" of this record by the laboratory in Southampton led to a re-sonification where the ear wants to detect something like music or speech but hear nothing but noisy patterns. "Message or noise?", Foucault once asked on occasion of a medical conference about the nature of bodily symptoms.[174] The results of this radically "superficial" reading have been presented at the JTS 2010 conference in Oslo (Digital Challenges and Digital Opportunities in Audiovisual Archiving):
The whole artefact's surface topology is mapped to high precision using optical sensors, and the audio recovered by applying signal and image processing methods to the measured data. The measurement process for this artefact took three weeks of continuous scanning. Initial attempts at audio recovery from the surface data using existing processing techniques were largely disappointing, leading to the development of a more sophisticated methodology based on feature tracking through the groove. Out of six short tracks found on the foil, four contained significant audio portions featuring both music and speech, the remaining two tracks were both short and contained negligible content.[175]
Such a technological (re-)sonification of transcoded signals is not just a concentional acoustic re-play; the media-archaeological *momentum* is ahistorical: "probably the first time it has been reproduced since the original recording date" <ibid.>. At the same time, this leads to a new kind of text criticism (in all its meanings); the real word of recorded acoustic signals reveals that the enclosed alphabetic commentary is historically untrue:

"The extracted audio <...> was not the expected psalm singing as documented in the contemporary sources, but a mixture of shorter extracts. Features of the grooves and the extracted audio may confirm that the foil is a small portion of the recorded foil, and that portions of the remaining foil could have been distributed to other guests of the event, consistent with contemporary practice." <Ibid.>

From such an operation sound is expected, but really what primarily can be heard is noise - just like the first (archived) recording of sound in Norway, a tinfoil flattened to a „document“ and annotated by a remark by a former collector who claims this has been the first Norwegian recording of music on Edison cylinder. The digital reading of this record (at a laboratory in Southampton) lead to nothing but noise. What articulates „it“self is noise such as can be expected in any transmission channel according to the theory of communication developed by Claude Shannons - a theorem which can be extended to transmission in time as well, that is: tradition. In such noise articulates itself what baroque allegories showed as the nagging „tooth of time“ - the articulation of physical entropy, the manifestation of the temporal arrow; according to the Second Law of Thermodynamics each system tends, over time, to increasing

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[174] Michel Foucault, "Message or bruit?", in: xxx

[175] P. J. Boltryk, J.W. McBride, L. Gaustad, Frode Weium, Audio recovery and identification of first Norwegian sound recording, Vortrag auf der JTS 2010 Konferenz in Oslo (Digital Challenges and Digital Opportunities in Audiovisual Archiving) <FIFA xxx>

dis-order.

Against the noise of physical decay, techno-logical, that is: „digital“ culture poses a negentropic insistance, a negation of decay and passing (away). Once digitized with an appropriate sampling rate, sound

[Digital copies of digital records can indeed be produced almost without loss of data (except the quantization noise[176]).]

can be re-produced frequently with stable quality which was utopean in recent times of analoge recording. The secret of this temporal unvulnerability is that it is just numbers which are electronically written; even after a thousand copies a physical representations of a zero stays zero and one probably remains one.[177]

All of the sudden, a non-literary texture, a binary pattern, saves the signal - the ultimate textual irony.

TECHNOLOGICAL VOICING OF TRAUMATIC MEMORY AND SONIC MEDIA TESTIMONY

From the phenomenological to the media-archaeological perspective: media-induced temporealities

Audiovisual signal recording has resulted in new kinds of temporal awareness and practices. From the phenomenological perspective, signal replay in photography, phonography, cinematography, videography, the magnetic tape, and finally digital recording affects the human and even animal sense of time. Spefifically the phonographic irritation has been iconized by the HMV record label *logo* (derived from Barraud's original painting) where the dog Nipper literally listens to "His Master's Voice".

In telephone directories of post-war West Germany, a special icon after the numerical address signified the possible interaction of an answering machine as a warning against the subsequent irritation of the present call.

This situation has been described by Walter Benjamin (referring to cinema) more acutely as a "chock" for sensation. Although for generations media records as text, sound or images have become accommodated in every day consumption, this intrusion into the sense of presence has not yet been cognitively digested and continues to irritate what might be called the "unconscious" of cultural time - in an explicit analogy to Walter Benjamin's neologism of an "optical unconscious" (inspired by Sigmund Freud's psychoanalysis), describing evidence which is not accessible to human senses but to the camera only - as revealed in slow motion and fast forward display.

Such media-induced temporal interruptions and incisions are traumatic tempo*realities* - pluralising the tightly coupled time triad of past-present-future into a whole cosm of micro-temporal figures of delay, anticipation and intra-temporal (time-critical) moments. These

[176] Siehe Wolfgang Hagen, Die Entropie der Photographie, in: Herta Wolf (Hg.), xxx

[177] Rudolf Taschner, Der Zahlen gigantische Schatten. Mathematik im Zeichen der Zeit, Wiesbaden (Vieweg) 3. Aufl. 2005, Anm. 77

temporealities share central features with what in recent academic memory studies has become known as the unhistoricizable of traumatic remembrance. Next to "the distinctive role of media in mediating collective trauma"[178], there is trauma induced by media technologies themselves.

An escalation of this situation is so-called *media witnessing* where crisis is not experienced as an exceptional eventality any more like historical revolutions or natural desasters in the past but "as a generalized and routine background condition - a persistent crisis-readiness" (Frosh / Pinchevski). In a more techno-radical reading, this background is no diffuse condition of contemporary society as described by sociology but is rooted in the time-critical conditions of such media technologies.

Broken presence: "Ringsendung" x-mas 1942

Phonographed voices do not simply articulate the original body but embody the co-articulation of the transmission technology itself. In the recording of the radio Christmas-greetings from several points of the war front, broadcasted by the German Großdeutscher Rundfunk on December 24, 1942[179], the human voice is traumatically distorted by electro-magnetic transmission itself.

The booklet of the Compact Disc edition of this recording reminds that such recordings are essential for the testimony of 20th century history. "Without them mentalities and tunings [*Stimmungen*] of that epoque can hardly be communicated."[180] But such tunings are not only cultural but directly results from the technical mode of AM transmission itself to which the present listener gets "attuned" (expressed in Martin Heidegger's sense).

Signal recording is not a witnessing of "Geschichte" which only takes place in historiographic narrative. Instead, it is an auto-referentialty of the transmission technology itself. The original (or even studio-manipulated) signal distortions are an index of authenticity of live radio transmission across long distances over the Short Wave military channels, a short-cut between soldiers at the war front and their families at home which can only take place in the technological radio-sphere. While this was meant to have a calming effect of synchronicity between relatives in Christmas time, sensation at home was at the same time irritated by the technical reminder of the spatial gap, the "shock of absence" audibly incorporated within the apparent temporal immediacy (Jan-Claas van Treeck). The liveness of the joint singing of "Stille Nacht, heilige Nacht" is spectral - both in its phenomenological sense (ghosts, the undead), but as well literally: the electromagnetic spectrum of the radio signal. The Freudean unconscious "It" expresses itself on the media-archaeological level, as a traumatic *momentum*.

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[178] Amit Pinchevski and Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial , in: Public Culture 22:2 (2010), 265-291 (267)

[179]See Dominik Schrage, "Singt alle mit uns gemeinsam in dieser Minute". Sound als Politik in der Weihnachtsringsendung 1942, in: Daniel Gethmann / Markus Stauff (eds.), Politiken der Medien, Berlin (diaphanes) 2005, 267-285

[180]"Ohne sie können Mentalitäten und Stimmungen dieser Epoche nur schwer vermittelt werden". Booklet to the Compact Disc published by Institut für Zeitgeschichte (Munich / Berlin) 2003, *Dokumentation Obersalzberg. Tondokumente. Täter Gegner Opfer*, ed. by Albert A. Feiber / Volker Dahm

The acoustic reverberations which take place, just like the spectral distortions and filters, provde the "live" transmission with a micro-temporal irritation. The present here is already distanced to itself, while at the same time letting a most intimate signifier of the German soul (the song *Stille Nacht*) shine through.

Amit Pinchevski and Tamar Liebes define radio wave transmission as "signals from afar that make intimate contact". While this applies to electronic communication media in general, "radio constitutes a distinctive configuration of presence-at-a-distance through the separation of body and voice and the reconstruction of a disembodied voice. [...] the body cannot endure transmission, whereas the voice can."[181]

This split between an original sound source and its electroacoustical recording results in what R. Murray Schafer called "schizophonia"[182] - a dissonance between the affective and the cognitive awareness of sonic time signals.

In electro-magnetic "acoustic space" (McLuhan[183]), a different tempor(e)ality reigns which allows for a rather "symphonic" resonance between past and the present which - what ever the semantic content - is the media-archaeological message of the technological condition for such radio transmission and reception itself: the "resonant circuit" in electronics (German *Schwingkreis*).

Even generations later the impact of such acoustic transmission of an event can still be "re-presenced" (Vivian Sobchack) in auditory perception which is the human surrogate time sense. The impact of the acoustic "real" does not only "affirm the effect of the original event"[184], but irritates and micro-traumatically undermines the symbolic time order of historical distance.

Future in the past: Storage driven by a virtual trauma

Phonographic recording and subsequent transcription of oral poetry has been undertaken for philological purposes like *guslari* epic songs in former Yugoslavia by Milman Parry and Albert Lord for the purpose of academic analysis, to answer by anachronistic analogy the "Homeric" question of how extended oral poetry works in a culture without writing. But in early twentieth century a couple of comparable projects in ethno-musicology such as performed by the Berlin Lautarchiv (resulting from prisoner recordings in World War One) are a technological function of traumatic anxiety about the disappearance of indigenous cultures, resulting in techno-

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[181]Amit Pinchevski and Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial , in: Public Culture 22:2 (2010), 265-291 (271)

[182]"Schizophonia is a term coined by R. Murray Schafer to describe the splitting of an original sound and its electroacoustic reproduction." en.wikipedia.org/wiki/Schizophonia#cite_note-1, accessed December 23, 2013, referring to: R. Murray Schafer, The New Soundscape: A handbook for the modern music teacher, BMI Canada, 1969

[183] See Edmund Carpenter / Marshall McLuhan, Acoustic space, in: Explorations in communication, edited by Edmund Carpenter and Marshall McLuhan, Boston (Beacon) 1960

[184] Amit Pinchevski and Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial , in: Public Culture 22:2 (2010), 265-291 (274)

archiving practices in the temporal mode of "future in the past".

Just like Alan Lomax' notorious recording of American folk songs had been commissioned by the Music Division of the Library on Congress, the same institution commissioned Paul Bowles (an American resident in Algier) to record native Maroccean folk songs and rhythms on magnetic tape (financed by a Rockefeller Fondation Grant) in 1959. Bowles' initiative was driven by the fear that recently independent Marocco was about to destroy that native folk music culture in an effort of national modernization.

In fact, the "cultural" reverse of the trauma linked with real genocides (notably the Armenian case or the Holocaust) is the persistent fearful anticipation of the future extinction of ethnic articulations of which the emerging audio-visual recording media like phonotgraphy, phonography, and cinematography are *both a symptom and an answer* since early 20th century.

Inbetween is the use of material (museum), signal-based (audio-visual recording) and symbolic (alphabetical) records to replace a living cultural memory by manipulatable storage, is was the case for the present with the *Theresienstadt* ghetto film from 1944/45 and the Central Jewish Museum project in Prague under German occupation 1940-43 to create a *futurum exactum*[185] - just like Albrecht Meydenbauers German Monument Archive (Deutsches Denkmälerarchiv), based around 1900 on photogrammetric measuring of historic architectural heritage, anticipated future destruction of the originals caused by possible wars already.

The pre-emptive media archive embodies the time-reversed trauma, known from grammar as "future in the past". It is from the technological condition of photography, cinematography and phonography itself that the traumatic *futurum exactum* as a kind of reverse non-historical trauma arose: the concept that a cultural articulation might *possibly* be extinguished and thus in anticipatory ways needs technical pre-recording.

Just like the phonographic archives established in Vienna and in Berlin around 1900, the photographic expeditions undertaken by Albert Kahn for his *Archives de la Planéte* in the 1930 and further projects, Bowles' Marroccean folk song recordings was driven by a kind of anticipatory trauma that the indigene culture he referred to was about to be extinguished. Appararently he never listened himself to the tapes he feverishly recorded; almost forgotten they time-invariantly rested in magnetic (rather than cultural) latency until they were discovered for re-play.[186]

This is not collective memory but a collection of recordings in technical storage - meant as memory of an anticipated *futurum exactum*, driven by a virtual trauma.[187]

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[185]See W. E., Symbolischer Tausch und der Tod (die Unmöglichkeit des Museum): das nationalsozialistische Projekt eines jüdischen Zentralmuseums in Prag, in: Geschichtswerkstatt 24 (July 1991), 45-56

[186] See Hans Ulrich Gumbrecht, Latency (forthcoming)

[187] The reverse is the current "Retromania" (Simon Reynolds) im popular music which compensates for the absence of utopean or avantgardist perspectives in current musical culture - a thought expressed by Jan Rohlf for the 2014 theme of CTM - Festival for Adventurous Music and Art "DIS CONTINUITY", Berlin (January / February, 2014)

"The archival potential of such <sc. phonographic> recordings came at a time when many indigenous cultures were already severely threatened, or had already disappeared, ironically as a result of the same Western industrialization that produces the technology used for the documentation. [...] the fact remains that the technology provided a literal documentation that surpassed the results of even the most sensitive transcriber. <...>

["[M]any ethnomusicologists were so conditioned by Western muscial practice that they intepreted what they heard and transcibred it according to Western musical notation, ignoring the microtonal variations that can still be heard on original recordings. Therefore, such objective documentation can be said <...> to preserve the aural artifacts of a culture"[188] - in facts its sonic *aura*. The technical recording (that is, the media-archaeological ear) preserves acoustic signals which might have already been obscured by symbolically coded cultural memory. Even if "[t]here is no guarantee that one can ever bridge the gaps between cultures" - and temporal distance between sonic articulations -, "the perspective of time and familiarity can certainly clear a way some of the veils that obscure a culture from us"[189] - revealing the sonicity of the cultural unconscious.]

Voice recordings from (beyond) the concentration camps

Storage media create a technical memory which differs from the dynamics of collective memory which linguistically emanates from social communication. But once biased by electric current again, the volatile magnetic remanence and the induced electric flux are as close as possible to what Maurice Halbwachs described as the mobile character of social memory. Especially when it comes to witnessing traumatic experience, a double structure arises:

On the level of direct evidence, media *record*, thus: technically *witness* traumatic experience; on the other hand there is a deeper, hidden traumatic irritation of a continuously present, that is: non-historicisable past which is a function of signal recording media themselves[190] - as has been demonstrated in Dan Graham's classic video installation *Present- Continuous - Past* (1974).

The recording of voices of displaced surviving prisoners from former Concentration Camps immediately after WWII took place on wire recorder - a machine used by Albert Lord as well when re-recording oral poetry from (partly) the same *guslari* singers decades after their first recording by Milman Parry's on aluminium discs.[191] Psychologist David P. Boder from Illinois Institute of Technology travelled to Europe in 1946 equipped with such a wire recorder. While Boder himself published the interviews in his *I Did Not Interview the Dead* (1949), the destiny of the wire spools themselves has been traced in Rosen's monography *The Wonder of Their Voices*.[192] The real wonder, though, is the bodiless, time-shifted repeatability of voices through

[188] Barry Truax, Acoustic Communication, Norwood, N. J. (Ablex) 1984, 118

[189] Truax ibid.

[190] This is one of the guiding theses in the research project *Archiving Presence* between Media Studies at Humboldt University, Berlin (W. E.) and Communication Studies at Hebrew University in Jerusalem (Amit Pinchevski) 2013-2015

[191] See Drubek 2013: 250

[192] Pinchevski 2012: 145, note 6

techno-logy (signal recording of the *logos*), since this time-shift is governed by technological rather than "collective memory" (dis-)continuities. A set of copies of Boder's spools arrived at the Library of Congress in Washington in the 1960s, about 20 years later - a period of latency both in the electro-magnetic essence and in the sense of historical time. The responsible sound engineer John Howell had to struggle with playback machines apt for spools of different sizes. He had to "recondition" it technically.[193] Where such a replay apparatus is missing, the signal carriers remain in latency. They are there, but do not "speak".[194]

The logic of memory maintenance and transmission of such records at first glance looks contingent but in fact "beneath the surface" - which is the media-archaeological level - "there was some rhyme and reason"[195] - the laws of techno-logic timing. The "technical" difference between signal memory (audio recordings) and symbolic memory (textual transcription), in Boder's case especially, is crucial for the re-discovery and the techincal recovery of Boder's interviews. "Boder's written work lived a life separate from the recordings that gave birth to them." Chronicling the destiny of the Boder materials "dramatizes how archival divisions splintered unified work into discrete components. Scholarship has likewise followed the shifting winds of technology; what is" - literally electro-magnetic - "current is what defines the field."[196] In Kittler's sense this means: Media determine the situation of collective memory.[197]

The case of the Boder interview argues the need to retain a *technical* knowledge of origins in the media-archaeological sense as a means to define what is significant, that is: what can be recognized as *signals* literally. "Otherwise, the wonder of their voice may never be heard."[198] But against being affectively being absorbed by the wonderous acoustic testimony, the media-archaeologial ear keeps distance. Distancing through technology is indicated in John Hersey's epic novel *The Wall*: "[...] if for Boder the wire recorder aided in a quest for versimilitude, in the case of Hersey is helped to liberate him from it."[199] There is an inherent paradox and a traumatic irritation for humanities in the fact that the most immediate reminder of a crime against humanity is itself of a complectely non-human nature: wire recording. In her book *How We Became Posthuman*, Katherine Hayles writes about Boder's association with the Illinois Institute of Technology where Camras propagated and improved the wire recording technology.[200] Camras obviously played a role in moving Boder to undertake what others did in more conventional ways of alphabetic recording. The 90 hours of Boder's vocal recordings can now be heard on the "Voices of the Holocaust" website.[201] Such recordings are not simply voices from the past but voices from survivors among the community of the otherwise dead:

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[193] See Alan Rosen, The Wonder of Their Voices. The 1946 Holocaust Interviews of David Boder, Oxford 2010, 168, and 280, note 55

[194] See the different wire recorder spool sizes as demonstrated in: Video Interchange (May 26, 2008) = http://www.videointerchange.com/wire_recorder1.htm

[195] Rosen 2010: 167

[196] Rosen 2010: 174

[197] See the "Preface" to Friedrich Kittler, Grammophone - Film - Typewriter [German Original 1986], Stanford 1999

[198] Rosen 2010: 174

[199] See the sub-chapter "Filtered from Documents: The Wire Recorder and John Hersey's *The Wall*", in: Rosen 2010: 171-174 (171)

reverse "collective memory", traumatic suspense resisting historic memorization.

A further wire tape from Boder's recordings has recently been discovered at the Cummings Center for the History of Psychology, University of Akron, Ohio, as a side-effect of Jon Endres' digitization project: "The discovery of this single canister holding a lost recording means that these songs can be heard again, they can be studied, and they can inform us in a new way about the experiences, the joys, and the frustrations of these displaced persons", and: "It felt like I was helping in some way to bring these voices to the present, voices that had become somewhat lost to the historical record."[202] But actually the songs could not be heard again without an intermediary interpreter, the wire recorder itself, to disclose the signals in non-historical latency to human understanding. The Cummings Center Blog is subtitled "exploring what it means to be human", and one response in the Blog answers *Such strong voices. Consider that these singers had just watched their loved ones destroyed.*[203] But it takes operative electronics as active media archaeologist of transmission of cultural tradition. "It took me a few days to get comfortable enough with the medium to put the Henonville Songs on to digitize – these are very fragile and I did not want to risk destroying history – but when I did I was blown away" (Endres) - techno-traumatically.

Several samples from the Henonville Songs spool are provided on the Cummings Center Blog: "Please give them a listen, they've been waiting a long time" (Endres). This hermeneutically presupposes a memory imperative to posterity which is not inherent in the technical signals themselves. Most personal responses to the blog post announcement of the finding get lost in sentimental hallucinations of the voice of the dead, ignoring the fact that digitization website has already transsubstantiated the techno-real of analog recordings into binary information which invites for a different form of intelligence. Algorithmic experimentation with such digitized audio evidence rather leads to non-hermeneutic discovery of hidden knowledge, like a spectral analysis of the timbres of the testimony voices, articulating a different, even counter-message than the verbal (or score) transcription of evidence.[204]

Disembodied voices from analog to digital analytics

The German Service of the BBC recorded voices of survivors immediately after the liberation of the concentration camp Bergen-Belsen to be broadcasted repeatedly *via* radio.

There is a specific sonic momentum of temporal indexicality, as expressed in the CD Booklet: The recordings are in manifold ways more authentic ("authentischer") than more recent

[200] Katherine Hayles, How We Became Posthuman. Virtual Bodies in Cybernetics, Literature, and Informatics, Chicago: University of Chicago Press, 1999. See David Morton, Armour Reseach Foundation and the Wire Recorder: How Academic Entrepreneurs Fail, in: Technology and Culture, vol. 39 (1998), 213-244

[201] http://voices.iit.edu; see FN 4 in Drubek 2013: 250

[202] https://centerhistorypsychology.wordpress.com/2016/09/02/dr-boder-and-the-missing-songs (accessed 8th February, 2017)

[203] Claudia Miriam Reed, February 7, 2017

[204] On such "active archive" experimentation with algorithms, see the research art group Constant (Brussels).

statements of witnesses which have been transformed by new experiences and mental processing - signal-witnessing. The recordings of the Jewish cellist Anita Lasker and Lotte Grunow are preserved in the Phonothek of Deutsches Rundfunkarchiv in Wiesbaden.[205] The booklet of its edition on Compact Disc tries to catch the medium specificity of such *signal memory*; referring to tape system-internal recordings "which illustrate the 'spirit' and character of the regime much more impressively than any printed text might ever achive"[206] - or archive.

On track 21 concentration camp survivor Lotte Grunow expresses her dispair with trying to organize her fresh memories into narratable form: "Da weiß man nicht, wo man anfangen soll" ("One does not know where to begin"). This rupture is the traumatic moment. At several instants of the recording, her voice seems to hesitate or to double for a micro-phonetic moment. Is this an index of *read* text, of traumatic speech iteration, or a technical effect of digital buffering of the audio file itself? In the latter case, the apparent traumatic shock turns out to be a function of technology itself.

A techno-sonic analysis of such recorded voices allows for the memorization of such traumatically experienced presence in revealing subtle nuances of voicing (somewhat deconstructing the message of the official "acousmatic" commentator voice from the *off*[207]).

Instead of traditional alphabetical transcription, linguistic analysis software like Praat allows for (and incites) new kinds of rather signal- than archive-b(i)ased mobilization of recorded memory: phonetic speech analysis, active archaeology of past sounds. In such algorithmic analysis, audio recordings from the the past are not just archival objects any more, but become items in an experimental laboratory of "archived presence". Semantic emphasis can be identified as a function of tonal pitch in the recorded voice, just as Max Planck - in a recording from 1939 in the Lautarchiv collection "Stimmen berühmter Persönlichkeiten"[208] raises (in German: "erhebt") his voice with the very German word "erhebt" itself, and lowers it with rhetorical skill at the end of his phrase in the last word "Gelehrten" (scholars). The techno-mathematical analysis of intonation, performed by Nikita Braguinski with the software Sonic Visualizer, reveals Planck's application of quasi-musical phrasing and thereby bridges the gap between semantics and affect.

Let us apply such sonic analytics to sonic records from traumatic past as well. Recent experiments with the "archival" *a priori* of digital audio memory organization have resulted in more dynamical tools of inquiry: search algorithms which are closer to the mechanism of human remembrance which is always in motion itself.

This allows e. g. for automatically tagging both intentional and non-intentional (even traumatic) "silence" in audio files - inaudible sound where nothing but time (and the recording medium) speaks, as provided by the "Analysis"-toolbar of the audio software Audacity under

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[205] They have been published on Compact Disc by the Institut für Zeitgeschichte (Munich / Berlin) 2003 *Dokumentation Obersalzberg. Tondokumente. Täter Gegner Opfer*, ed. by Albert A. Feiber / Volker Dahm, track 20 and 21

[206] "<...> die <...> 'Geist' und Charakter des Regimes sehr viel eindringlicher veranschaulichen, als dies ein gedruckter Text je könnte"

[207] See Michel Chion, Audio-vision. Sound on screen, New York (Columbia University Press) 1990

[208] See Web site of the Lautarchiv = B8-29 Max Planck

the explicit term of "Silence Finder".

This tool might be applied to the magnetic tapes from the historic Frankfurt Auschwitz trial.

The notion of "crisis" is linked to the very time-criticality of real-time signal processing technologies of today like *online* and *streaming* media. Whereas analog live electronics in its potential transmissibility of almost all events still adhered to the linear temporal unfolding of events as represented in historiography, the almost immedate, non-linear accessability of Internet websites is more akin to what physicists call a 'wormhole' - a shortcut connecting distant points in space and time"[209]. This tunneling of temporal distance (to refer to the quantum-mechanical terminology) undermines the dominance of historical discourse in negotiting emphatic time experience.

Media technologies starting with photography have been associated with attempts to communicate with the dead. "By extending indefinitely the gap between the body and its traces, by exceeding the ontological opposition between presence and absence, media technologies conjure up a 'spectral logic'."[210]

Visual presence is based on electro-magnetic wave signal transmission ("radio"-like): almost immediate, whereas acoustic sensation is based on comparatively slow signal run-tíme in mechanical matter:

"I can be touched, *presently*, by the recorded speech of someone who is dead. I can, *here and now*, be affected by a voice beyond the grave."[211] But according to an hypothesis developed by John Durham Peters, this double *mediumism* only takes place with analogue media and abruptly ends with digital data processing.

Signal recording performs the *in*distinction between message and noise, referential recording and the articulation of the recording device itself - while binary data - though technically still being embodied in electrophysics and driven by current energy - *per definitionem* in communication theory abstract from the material implementation.

Different from reading historiographical writing, the audio channell has an almost ahistorical power of presence, even if cognitively the recording from the past is immediately contextualized as historical. The recording of the acoustically or optically "real" physical signal is opposed to symbolic notation by the alphabet not only in a technical but also in an epistemological way: the difference between physical signal as indexical and the arbitrary cultural symbol. With computing, though, this dialectic opposition becomes synthesized, since Digital Signal Processing (notably sampling of audio events) is a function of discrete symbolization, a re-entry of the "alphabet" in numerical and logical form.

If according to Walter Ong the electronic revolution in mass media communication devices like

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[209] Frosh / Pinchevski 2009: 303

[210] Amit Pinchevski and Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial, in: Public Culture 22:2 (2010), 265-291 (283, quoting an expression by Jacques Derrida and Bernard Stiegler, Echographies of Television, Cambridge (Polity) 2002, 117

[211] Jacques Derrida, Above all, no journalism, in: H. de Vries / Samuel Weber (eds), Religion and Media, Stanford, CA (Stanford University Press) 2001, 56-94 (71)

radio and television has led to a "secondary orality", communication based on the symbolic machine (computing) has led to a (hidden) secondary alphabetic revolution, with bits and bytes inheriting the typeset, but different from the printing culture in a dynamic way.

The voice turns silent and still articulates - in implicity mathematical sonicity which is the ultimate shock to occidental logocentrism.

Sonic media testimony and the audio-visual gap: *Theresienstadt*

The time figure of "archiving the present" *in realtime* and the techno-archival drive to encapsulate audio-visual evidence by preemptive technical recording consciously or unconsciously counter-balances feared or planned cultural and even human extinction - just like in World Ware II anti-aircraft artillery calculated the immediate future of the enemy aircraft behaviour in order to anticipate its lethal action - counter-calculating the present. The use of material (museum), signal-based (audio-visual recording) and symbolic (alphabetical) records hereby replaces a living cultural memory by manipulatable storage, is was the case for the present with the *Theresienstadt* ghetto film from 1944/45 and the Central Jewish Museum project in Prague under German occupation 1940-43 to create a *futurum exactum*[212] - both commissioned by the German SS.

In the case of the voices of German Jews recorded for that film under the contemporary title *Theresienstadt. Ein Dokumentarfilm aus dem jüdischen Siedlungsgebiet* (1944/45)[213], the recordings are an indexical trace of a traumatic experience preserved even against the covering German commentator voice.

After the voices of the Jewish prisoners had been used for this sound film, "most of them were eventually killed, as they were witnesses of the filming"; they were either murdered or left Theresienstadt for Auschwitz almost immediately after the shooting of the film in the so-called *Herbsttransporte* of 1944. "This makes the voices in this film a rare document from the camps still waiting to he heard: the recordings from the Thresienstadt film are yet undeciphered audio 'kassibers'"[214], writes Natascha Drubek. And Drubek further: "The film presents a challenge, confronting us as an audiovisual document of a 'presence' which begs for deciphering, as it is referring to the invisible and inaudible 'absence'. Analyzing the film we become aware that even the exploited voices carry 'kassibers'."[215] Yet the term *kassiber* ("from the Yiddish word *kesive* which means writ, letter"[216]) which refers to the symbolic (i. e. historiographical) regime misses the memory specificity of electronic signal recording.

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[212] See W. E., Symbolischer Tausch und der Tod (die Unmöglichkeit des Museum): das nationalsozialistische Projekt eines jüdischen Zentralmuseums in Prag, in: Geschichtswerkstatt 24 (July 1991), 45-56

[213] See Natascha Drubek, The Exploited Recordings. Czech and German Voices in the Film "Theresienstadt. Ein Dokumentarfilm aus dem jüdischen Siedlungsgebiet" (1944/45), in: Zakharine / Meise (eds) 2013, 249-273

[214] Natascha Drubek 2013: 254

[215] Drubek 2013: 269

[216] Drubek 2013: 252

Black Boxes of sonic memory

In May 2011 two aeroplane Black Boxes could finally be saved from the submarine ground of the Atlantic - the data recorder *plus* the voice recorder keeping not only the last words of the pilots in the cockpit but as well the background noises which might retrospectively signal the unfolding desaster. The wave forms and sonagrams both voice signal and all kind of noise, mixed, often undistinguishable. Both devices proved to be miraculously intact two years after the 2009 crash of the Airbus of Air France. Both data recorders consist of memory chips which keep their magnetic charge, different from the mechanically vulnerable turning cylinders, discs or tape or wire spools of previous recording media. Whereas mechanical records still provide the culturally familiar form of physical impression (writing), electro-magnetic latency is a different, sublime, uncanny form of insivible, non-haptic memory. Listening to the recovered voice recorder from the cockpit after a plane crash is traumatic immediacy, rather re-enactment than protocol. The voices and sounds emanating from such a black box are radically bodiless, being in a different temporality than the familiar historiographical time.

Radiophonic testimony and media-archaeological voice analysis

Whereas *aura* as defined by Walter Benjamin depends on the impression of being uniquely "here and now", technological temp*oral*ity and specifically its sonic articulations culminate in a deferred and delayed presence, the electrified voice and its media-temp*aural*ity. Next to transcriptive "oral history", a techno-aural presence of the past takes shape.

As has been argued by Pinchevski and Liebes, the live radio transmissions of the Eichmann trial in 1961 "became inseparable from the memory of the trial itself <...>."[217] In terms of the electro-magnetic event, the authenticity of the media event, and the co-witnessing affect of radio voice transmission is preserved in its recording on magnetic tape. From that technological condition arises a unique option for time-shifted re-presencing traumatic testimony. While the affect of traumatic testimony disappears when recorded in alphabetic historiography, it is preserved in signal transduction.

A kind of acoustic memory shock has been the unexpected turning-up of a *mémoire involontaire*, a magnetic recording of Hitler's voice on a AEG tape, recorded by microphones once installed in the train waggon which carried Hitler and the Finnish General Field Marshall Carl Gustaf Emil Mannerheim on occasion of Hitler's visit in 1942, on occasion of Mannerheim's 75th birthday, at a train station near the airport of Immola in Finland. Eleven minutes were secretly recorded by Thor Damen, a sound engineer of the Finnish Broadcasting Company (Yleisradio) on June 4.

While Hitler rarely allowed himself to be photographed, filmed or phono-recorded in private situations, all of the sudden, the secret media archive lets him speak in a private tone. "The voice on the tape is low-pitched and somewhat hoarse, with sentences rambling, and breaking off repeatedly into pauses for thought."[218]

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[217] Amit Pinchevski and Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial , in: Public Culture 22:2 (2010), 265-291 (267)

[218] Kirsikka Moring, Conversation secretly recorded in Finland helped German

This invites for spectrographic signal analysis. There are archival pauses in the historical sense (the event) and as techno-archival event as well:

"The recording was suddenly cut off. Hitler's security men spotted the cords coming out of the window. They raised a fuss, threatening Damen with a gesture suggesting cutting off the throat. According to Vihonen, the security men demanded that the tape be immediately destroyed, but Yleisradio was allowed to keep the reel, after promising to keep it in a sealed container.
One of the tapes ended up in the hands of the head of the state censors' office Kustaa Vilkuna, and he later gave it to Yleisradio in 1957. The second tape was kept by Damen himself, who died in 1965. It was found in 1992 by his son Henrik Damen, hidden away in his father's garage."

A copy of the tape was sent to the Institute of Military History of the German Armed Forces. A study of the tape's authenticity was made in the acoustics laboratory of the German Central Criminal Police. But paradoxically, it is exactly such signal analysis in quest of the authentic voice which reveals the monstrosity (in Fact: the Sirenic sonicity) of the human voice when analyzed (and resynthesized) as a techno-physical event.

The American sound artist Seth Cluett once coined the term "temporal dissonance" for such irritations. "Dissonance" in itself is of a sonic-temporal nature (different from simple "dislocation"). Sonic asynchronicities create irritations in the human sense of time (different pace / temporalities / speed).

Stefan Gfrörer from German BKA (Kriminaltechnik) identified Hitler's voice by comparison with officially recorded Hitler public speeches. Forensic technology is truly media-archaeological analysis.[219]

Not only the human is speaking from tape - it is the recording technology itself as well. Gfrörer "compared the speech to a talk Hitler had just previously held and which was recorded by using exactly the same system as in Finland, and the analysis proved that it was Hitler talking."[220]

Hitler's personal assistant who had been present during the train journey could not recognize the recorded voice as specifically Hitler's one - a difference between neuronal and electronic memory. The stored recording of Hitler's conversation with Mannerheim during lunch at the train journey breaks of when suddenly music can be heard - the previous recording of the

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actor prepare for Hitler role, In: Helsingin Sanomat International Web-Edition, *online* http://www.hs.fi/english/article/1076153999513 (accessed March 19, 2013. First published in print: Helsingin Sanomat, September 15, 2004. For a YouTube-reproduction of the document, see: "Hitler 'Talking' To Finnish Field Marshall Mannerheim" = http://www.youtube.com/watch?v=t_Xf3l7RjBk; accessed March 19, 2013

[219] See Matthew Kirschenbaum, Mechanism. xxx, xxx 2010

[220] http://www.ww2f.com/topic/1497-the-conversation-between-mannerheim-and-hitler; accessed March 19, 2013

(radio) tape. The authentification of the recorded voice as Hitler's (which is symbolically rendering a name as meta-data to an audio signal) itself is a media-archaeologial act, based not on human memory (Hitler's former assistant) but on stectography, with signal-detecting and signal-analyzing electronics / measuring instruments. What flashes out, is the physically "real" of acoustics. Different from Roland Barthes' definition of the photographic *punctum*, the signal here is a dynamic one, revealing its evidence only when moving forward, a kind of "punctum-in-becoming" like the cathode ray which creates the impression of an electronic image which in fact consists of nothing but Bergsonean time of duration.[221]

This reminds of the gramophone recording of Heinrich Himmler's "secret" speech to SS men on the *Endlösung*; my controversy with the film maker Romoald Karmaker during the Berlin Berlinale screening of his "documentary" film with the speech being alternatively not rendered from the original recording in the Federal (?) Archives but read by the actor Zapatka.

***Different Trains*: Traumatic memory triggered by the sound archive**

In his novel from 1880, *L'Eve Future*, Vielliers de l'Isle-Adam lets the inventor of the phonograph, Thomas Alva Edison, lament on the sonic information which has been lost in world history. But even the phonograph reaches its limits when it comes to record the purely physical noise, since it is technically too noisy itself: "Ansi, j`eusse blâmé, par exemple, le Phonographe de son impuissance à reproduire, en tant que *bruits*, le bruit ... de la Chute de l'Empire romain ... les bruits qui courent ... les silences *éloquents* ... ."[222]

Such noise becomes expressive of traumatic memory in Steve Reich's minimalistic composition *Different Trains* (1988): acoustic memories of train journeys in the past, train speed sounds as sonic commentary of different tempor(e)alities, rivalling with the mixed-in voices of train porters as oral testimonies. Reich collected recordings not only of American trains from the thirties and fourties, but from Europe as well: „There they sound completely different, they have another whistle, really violent" - "*schrecklich*", as verbally expressed by the composer.

Track I "America - Before the War"; Track II "Europe - During the War" (Kronos Quartet); Track III "America - After the War"

Minute sonic differences here account for the discontinuity inbetween historical epoques. But this mode of experiencing the past probably is not historical at all, since it cannot be expressed historiographically (which is limited to symbolic writing). It is, rather, sonography of the real in cultural time: "The real train sounds, that is all."[223]

The composer's basic idea was that speech recordings generate the musical material for musical instruments." In order to combine the taped speech with the string instruments he selected small speech samples that were more or less clearly pitched and then notated them as accurately as possible in musical notation. The strings then literally imiate that speech melody." Even if this manual transcription into the symbolic score seems to represents human

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[221] See Bergson, Matter and Memory, on "vibrations", and Maurizio Lazzarato, Videophilosophie, Berlin (b-books) 2002

[222] Édition Lausanne (L'Age d'Homme) 1979, 36

[223] Steve Reich, in: xxx

interpretation, in fact it already enacts an inhuman approach to the voice which is the technical operation of the the Vocoder (literally: "voice encoder").

"Built at the Bell Telephone Laboratories of American Telephone and Telegraph (AT&T), this machine was intended for communicating multiple messages to be passed down the same telephone wire simultaneously. But the real message of the medium is this: "[...] it indicated that certain aspects of a vocalization could be subtracted without a listener perceiving any change. Speech could be broken into bits, much like 'the subject' — which, Lacan had earlier announced, 'is no one. It is decomposed, in pieces.'"[224]

The excerpts from testimonies of Holocaust survivors come from the several testimony collections and the train sounds from special recordings; Siren and Warning bell sound comes from Elektra Records Sound Effects.In one of the oral testimonies, in the third act, an aged train porter comments: "but today, they're all gone". The temporality of the transient sonic articulation which is the medium message of the musical composition here coincides with the notion of history as its content.

In Reich's composition for string quartett and magnetic tape, the train sounds serve as non-human testimony of bygone times, returning to Reich's early speech-archaeological pieces like *It's gonna rain* and *Come out*. The sound of trains from the years 1939-42 (the years when Reich himself made train journeys between his parents in separation between New York, Chicago and Los Angeles) makes him comment that in these years in Europa, as a Jew he would probably have been transported in such trains to a concentration camp.

The first act refers to pre-War trains in America, the second for Europe. He went to the Yale Fortunoff archive and took the audio track, searching for the speech melodies of European Holocaust survivors. The he collected trains sounds from the pre-war US and from Europe.

Trauma, according to Sigmund Freud, is such signals against which the human ear has no defence, which breaks into human perception as radical presence even if cognitively it is known that the signal source is archival recording from times past.[225] The symbolic order of historical narrative then is not capable any more to shelter against such temporal affectation.

But then, Reich destilled samples from the oral voices and sent these archival signals to a Sampling Keyboard which digitally samples and holds signals from natural sources. It has been the computer which helped him to "organize it all"[226] Reich celebrates such signal processing as a liberation from the restrictions of subject-centered historical narrative; if one submits to such sound processing, human attention is diverted from the "he, she, you" to the "it"[227] - a truly media-archaeological aesthetics, a different, non-hermeneutic kind of "understanding",

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[224]Mills 2010: 36, quoting Jacques Lacan, The Seminar of Jacques Lacan, Book II: The Ego in Freud's Theory and in the Technique of Psychoanalysis, 1954 – 1955, ed. Jacques-Alain Miller, trans. Sylvana Tomaselli (New York: Norton, 1991), 54

[225] "Solche Erregungen von außen, die stark genug sind, den Reizschutz zu durchbrechen, heißen wir *traumatische*.": Sigmund Freud, Gesammelte Werke, edited by A. Freud, E. Bibring, W. Hoffer, E. Kris und O. Isakower, London / Frankfurt (Main) 1999, vol. XIII, 29

[226] "Vorwärts und zurück. Steve Reich im Gespräch" mit Gisela Gronemeyer, in: MusikTexte 26 (Köln, Oktober 1988), 11-15 (11 f.)

literally, coupled to another temporal field. The temporality of the "Es" is not historical any more, since computational sound processing de-humanizes such voices.

Sometimes, it happens that life assurances still pay money to the dead; digital administration can not differentiate in adressing names between the living and the dead (esp. when subject to the "millenium bug" dates). On the other side there is digital technology as research tools, such as in the European Holocaust Research Infrastructure (EHRI) which recovers the names of thousands of Jews killed in concentration camps so far unknown - by digitising textual and audiovisual records of various administrative and other archival context.[228]But computing itself resonates with the leased IBM machines which helped to organize the concentration camp administration at these years on the German side.

Negative sound as traumatic interval: silence as form of sonic witnessing

With sound recording in digital high fidelity (due to lossless signal reproduction according to the Nyquist / Shannon sampling theorem), the traditional tight coupling (at court and in legal discourse) of indexical phonographical real presence and witnessing is being undermined.

Arnold Dreyblatt's "memory opera" performance, reading printed names by actual voices, once reimplemented the symbolical rigid signifiers into real living bodies by human re-presencing (different from re-play by phonographic apparatuses) - like the "sonic memorial" of September 11 attack on World Trade Towers 2001, by US Public Radio.[229]

A Compact Disc by Jonty Semper, edited September 6, 2001 (shortly before the attack on the New York World Trade Towers on September 11, 2001: see "radio memorial") allows for the re-play of the recording of "The one minute silence from the funeral of Diana, Princess of Wales" which on September 6, 1997, was broadcasted *in memoriam* Lady Diana on radio and TV.[230]

But just as for the recorded silences in the video-testimonies at the Yale Fortunoff Archive such silence is no articulation of trauma any more but by the very act of recording already the transformation of real into symbolic silence which thereby becomes accessible to the historiographical imaginary.

Wheresas traumatic silence escapes recording, the repeatability of recording itself creates a trauma of another kind by its very technological virtue: an irritation of logocentristic

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[227] "<...> eine Lenkung der Aufmerksamkeit weg vom *Er*, *Sie*, *Du* und *Ich* hinaus zum Es": Steve Reich, Musik als gradueller Prozeß, in H. Danuser, D. Kämper u. P. Terse (eds.), Amerikanische Musik seit Charles Ives. Interpretationen, Quellentexte, Komponistenmonographien (Laaber, 1987), 288-290

[228] See Gerhard Lauer, Die digitale Vermessung der Kultur. Geisteswissenschaften als Digital Humanities, in: Heinrich Geiselberger / Tobias Moorstedt (Redaktion), Big Data. Das neue Versprechen der Allwissenheit, Berlin (Suhrkamp) 2013, 99-116 (109f)

[229] See the audio project *Kenotaphion*; www.kenotaphion.org

[230] See Claudia Benthien, Die *vanitas* der Stimme. Verstummen und Schweigen in bildender Kunst, Literatur, Theater und Ritual, in: Kolesch / Krämer (eds.) 2006: 237-268 (262)

"presence". Silence recorded on magnetic tape though makes silence accessible as processual *durée* (in the Bergsonean sense) by its very necessity of a electro-magnetic and motor driven motion.

Interruptions may then be taken as kind of negative presence effects insofar as hereby "the nonhermeneutic <...> punctuates the hermeneutic <...>."[231] The equivalent to spatial, material or visual absence is negative sonicity: silence. In trauma studies, pauses and interruptions in recorded speech count as symptoms - symptoms which can better be identified by ultra-sensible and DSP measuring media than by human psychoanalysts. But from the media-archaeological point of view (the "ears" of the recording apparatus), speech and pauses are equally forms of signals. Frequently interview quotes and diary material are anonymized, and "[a] series of dots ... indicates a pause in speech."[232] The *real* involuntary memory (in Lacan's sense) is *arché*-logique (no speech / *lógos*), but articulation by silence. In algorithmic techno-memory practice, there is a "Silence finder" tool in the audio-editing software Audacity which automatically, that is: algorithmically, taggs intentional and non-intentional pauses in speech or sound files. The present text will dis-continue at that point.

MICRO-DRAMA / TECHNO-TRAUMA. Inbetween theatre as cultural form and true Media Theatre

Introducing Samuel Beckett's media theater

An media archaeological investigation of phonographic archives, including the challenge of their restoration and preservation, takes its departure from the technical conditions of sound recording such as the Edison Phonograph and subsequent material sound carriers[233], while not reducing it to the history of technology but as *arché* of a differnt kind, tracing the epistemological implications of what becomes of sound and speech once it can be technically addressed as signals. Very soon, a sono-technical world of its own unfolds, both in terms of analysis and synthesis, and its analog and digital hard- and software tools, to which culture and manking is rather peripheral. Technique-oriented ontology grants media as artefacts a knowledge sphere of its own for which the anthropocentristic, phenomenological supremacy is suspended (for an *epoché*). Radical media archaeological analysis goes beyond discourse-oriented media studies which reads media-involving dramas like Beckett's *Krapp's Last Tape* as aesthetic, artistic or intellectual symptoms of a technical *a priori*; its investigation rather epistemologically immerses into the medium artefactuality itself, tracing its implicit techno-cultural knowledge.

In Peter Weibel's media art installation *ichmasse-masseich* (1977/78), three magnetophones are positioned in front of corresponding three human figures. Each moment an endless tape loop passes the inductive coils of one magnetophone, the sound "me" ("ICH") is articulated. While the audience intuitively relates this expression to the human figures, in fact the reverse is true: It its the magnetophonic machine which is granted to articulate an "ego"; the 2012 re-installation for the ZKM Karlsruhe exhibition *Sound Art* actually by-passed the co-presence of

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[231] Pinchevski, "Levinas as media theorist", in: xxx

[232] Ben Anderson, Recorded music and practices of remembering, in: Social and Cultural Geography, vol. 5, No. 1, March 2004, 3-19 (18)

[233] As displayed in the exhibition *[Sound] Listening to the World*, featuring the century-old Berlin *Lautarchiv* and *Phonogrammarchiv*, Humboldt-Box, Berlin, March to September 2018

human figures completely.[234] The media-archaeological focus is not on the question of what media studies can contribute to a proper understanding of dramatic intentions, neither does it reduce 20th century theatre to functions of a technical *a priori* in the Kantean sense. It rather understands such dramatization from the point of view of the machine. For the historical approach, it takes sound philology and archival research to contextualize Beckett's oeuvre in his contemporary media culture, while at the same time a radically media-archaeological reading of his one-act drama from 1958 *Krapp's Last Tape* (KLT)[235] discovers a different micro-dramatic emergence *from within* the media sphere of magnetophony - its technological "sonicity".

A non-historicist reading of KLT does not circle around the rigid denominator "Beckett" and does not aim at reconstructing the idiosyncratic intentions of an individual author but understands KLT as an instanciation of the technological unconscious in culture. Different from physical objects investigated by natural sciences, even the most inhuman apparatus, such as the electronics of the magnetophone, is a cultural artefact, the result of techno-logical knowledge accumulated for centuries. The implicit knowledge and "message" of a new technology expresses itself even involuntarily the moment a human author makes use of its affordances.

In that sense, as originally and precisely suggested in Julian Murphet's contribution to the *Beckett and the Media* conference of Basel University[236], the actual medium message of the two versions of Beckett's 1981 television play Quad (I for colour TV, II for black & white) featuring four actors dressed in white, red, blue and yellow robes walking around and diagonally across a square stage in fixed patterns, is the time-critical, time-delayed micro-drama of squeezing RGB colour information into the delicate black & white TV signal - analytically addressed in engineering as the "colour clock". This rather autopoietic techological self-expression unfolds below the apparent dramatic "content" intended by the author, which has mostly been interpreted as a formal experiment in geometricized mime.[237]

From that level of the time-based techno-cultural unconscious, a fundamental *techno-drama* unfolds. When Krapp, after a moment of "musing" in front of the magnetophone, tears the tape spaghetti out and throws it away, such a techno-traumatic excess results from either positive or negative feedback in the coupling of human memory with machine storage.[238] In KLT, the human actor experiences the technically preserved voice of his former self. Already the Edison phonograph resulted in a shock within the cultural unconscious, since (as has been defined by

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[234]http://soundart.zkm.de/ichmasse-massenich-19771982-idee-1977-peter-weibel, accessed March 26, 2018

[235] Samuel Beckett, Krapp’s Last Tape and Embers, London (Faber & Faber) 1958; republished 1965

[236] Mariastein, 23/24 May, 2018

[237] See Wikipedia entry "*Quad* (play)", accessed March 2018

[238] See Wolf Kittler, Digitale und analoge Speicher. Zum Begriff der Memoria in der Literatur des 20. Jahrhunderts, in: Anselm Haverkamp / Renate Lachmann (Hg.), Gedächtniskunst: Raum - Bild - Schrift, Frankfurt/M. (Suhrkamp) 1991, 387-408, with a focus on J. L. Borges' essay *Die analytische Sprache John Wilkins* and Beckett's drama KLT

G. W. F. Hegel) the "tone" (including the voice) had - phonocentristically - been the most ephemeral and presence-dependent form of articulation of the individual self. All of the sudden, this very uniqueness could be technically repeated.

From the medium-specific operativity and technological *Eigenzeit* of the magnetophone stems a techno-traumatic affect. The reiterabillity of the human voice from recording media even beyond their bodily death has been a chock experience in terms of phenomenology. Such a dramatic temporality stems from the medium itself, its real message (in McLuhan's sense) or rather: the "real" as technological message - as "an experience that is registered without being processed or experienced in the full sense"[239].

In the case of KLT, Krapp's disembodied voice is dislocated from the symbolic regime (the traditional diary) into the real of the voice-recording machine itself (magnetophone), resulting in a *techno*-traumatic irritation.

There is a specific tempor(e)ality (oscillating between tempORALity / tempAURAlity) in the human voice when recorded on magnetic tape. Electro-technological media inscribe the voice into cultural memory by signals instead of symbols. Whereas alphabetic recording of speech looses the *hic et nunc* of the event[240], technical voice recording preserves the presence-generating power of signal replay. The specific characteristic of *aura* as defined by Walter Benjamin depends on the impression of its being "here and now". Specifically its sonic articulations culminating are echoed by technological temp*aura*lity.[241]

From this perspective in KLT, essential issues are the attempt to receive authentic remembrance from technical memory and the techno-trauma caused by disembodied voices. The tape recorder is – although it is nonhuman – the second and equally important actor on stage. Therefore Krapp’s Last Tape counts as genuine media theatre. The co-presence of a human actor and a tape recorder in KLT, in technical terms, is a loose *coupling* which constitutes a comprehensive *system* - a cybernetic concept which has been the dominant *epistemé* at the epoque when Beckett wrote his play.

This extends to the temporal dimension as well. Once a human is coupled to a signal storage and processing media interface, is becomes subjects to the apparative temporalities. What happens when psychic "latency" becomes magnet signal recording? Not only is the configuration of a human protagonist (Krapp) and a high-technological device (the magnetophone) a microsocial configuration in the sense of Actor-Network Theory or an *ensemble* in Gilbert Simondon's sense, but the close coupling of human and machine on stage asks for a more rigorous analysis of the cognitive, affective, even traumatic irritations induced in humans by the signal transducing machine.

Different from the theatrical stage which can only reveal the phenomenological effects induced by technologies, media theatre is not simply performed by human actors (like Krapp) enhanced

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[239] Brand 2009: 198

[240]John Durham Peters, Witnessing, in: Paul Frosh / Amit Pinchevski (eds), Media witnessing. Testimony in the age of mass communication, Houndmills (Palgrave Macmillan) 2009, 23–41 (35)

[241]For a somewhat related use of that term, see Samuel M. Weber, Mass Mediauras: Essays on Art, Technics and Media, Stanford UP 1996

by media; the real micro-drama rather unfolds *within* analog signal circuitry such as the magnetophone and algorithmic technologies. There is signal transduction in analog electronic media, and signal processing in digital media.

The media-theatrical concept correlates with a different method of analysis. Apart from hermeneutic *exegesis* and *ekphrasis* of what has been written by Beckett in his script already, unfolding its different layers of meaning, media archaeography rather identifies what escapes the script, assuming that the magnetophone knows more than its external author.

KLT insistantly unfolds the clash between the symbolic regime (language, writing, archival records) with the phono-technical real. Three kind of agencies unfold: human remembrance (Krapp), the symbolic memory order (the ledger as tape inventory), and signal storage technology (magnetophone). Media-philological attention therefore reads KLT as an operational function of the epistemic challenges and opportunities posed by electro-acoustic time axis manipulations in the 1950s / 1960s, while at the same time resisting to simply extend the terminology of literary genres to the analysis of magnetic voice recording.

Instead of anthropocentric, human- and cultural performance-oriented discourse analysis which tends to metaphorize human "memory" in terms of respective storage technologies, and identifies the dramatization of electronic recording such as Beckett's KLT simply as a discursive symptom of technical "affordances", media archaeology more radically breaks out of the hermeneutic circle in favour of an analysis of the non-discursive techno-processual event itself. "Media phenomenologists [...] analyze how phenomena in various media appear to the human cognitive apparatus, that is, to the mind and senses."[242] While in the latter mode, any ekphrasis of the magnetic tape factor in KLT or in William Burrough's novel *The Ticket that Exploded*, tends to re-humanize the techno-trauma by integrating it into the symbolic order of an anthropocentric narrative[243], media archaeography rather externalizes the technological challenge.

Archival research can be helpul in explaining the triggering of an operation. In the case of Beckett, the author had been asked, in 1956, to write a radio play for BBC, resulting in the broadcasting in 1957 of *All That Fall*. During that production, BBC made a (at that time) new technology available to Beckett, the magnetophone, which allowed for acoustic monitoring and sonic control by playback. In terms of biographical narrative, this experience with functional dramaturgy resulted in Beckett's integration of a magnetophone in the subsequent play KLT.[244]

Instead of philologically reconstructing the influences and steps on Beckett which successively resulted in the KLT play, media archaeological analysis starts from the factuality of the actual human-machine symbiosis as the core (of the) drama and replaces the author-centered hermeneutics by a technol-logical analysis: What is the techno-epistemology which conditioned the possibility for Beckett to be dramatically seduced by the affordance of a

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[242] Kjetil Jakobsen, in chapter 6 of his text "Anarchival Society", discusses "Archaeology versus phenomenology", in: Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010, 127-154 (141)

[243]Such as Michael Lommel, samuel Beckett. Synästhesie als Medienspiel, Munich (Fink) 2006

[244]An argument in John Fuegi, Brecht, Beckett und der Text im Zeitalter der Technologie, in: Knut Hickethier / Siegfried Zielinski (eds.), Medien/Kultur. Schnittstellen zwischen Medienwissenschaft, Medienpraxis und gesellschaftlicher Kommunikation, Berlin 1991, 356

magnetophone?

Once the analytic focus is on the techno-phonic (and -logic) *medium* message of KLT, it becomes *inductive* in the precise sense of electro-magnetic induction which is the technological condition (the *arché*) of possibility of the drama unfolding in KLT at all. From the question whether Krapp's voice, once transduced into magnetic latency, is still human, arises the attempt to define the qualities of real *media theatre*.

The untimeliness of KLT

It has been frequently remarked in Beckett scholarship that in 1958 the technical temporality claimed in the play has been an anachronism, since the suggested 45 years of birthday tape recording by Krapp is a techno-historically impossibility, predating the actual development of the AEG tape recorder by decades. Therefore it was appropriate for Beckett to diegetically place the play "some time in the future" (introductory remark). Such time-shifting is the essence of spool-based tape recording and replay itself.

But a different future had already arrived in 1958. A radical "schizophonic" (Schaefer) rupture between the human and his / her voice occurred with synthetic voices. While Beckett was still writing his drama KLT, Bell Laboratories in the US already experimented with the "vo(co)der", with artificial speech synthesis.

Besides, the *arché-logos* of magnetic voice recording actually dates back to 1900 when Pouslen presented his "Telegraphon" at the Paris World Fare; with Oberlin Smith's circuit diagram, magnetic recording (explicitely targetted at speech dictation in office, and the telephonic answering machine even co-originated (as an electric answer) with the Edison phonograph. At that moment, another media-epistemologic gap opens: While the phonographic groove visibly and haptically still comforts the human bias to integrate the technical recording within the familiar cultural techniques of writing[245], the electric transduction of the acoustic voice into sublime field recording does not reveal itself immediately to the human sensory apparatus any more.

[Technical sound carriers do not just replace each other in an evolutionary course of technology. The phonograph respectively the grammophone record on the on hand, the magnetic record on tape on the other, and finally the digital recording represent fundamentally different materialities and essences in terms of their technological registering of time-variant signals, time-based forms of reproduction and their function as time-channel in individual communication *alias* cultural tradition. In the case of phonography *versus* magnetophone, electronics makes a difference. The magnetic (audio) tape’s logics diverges from phonographic linear inscription and rather connects to "non-linear cultural techniques (splicing, looping, dubbing)" and affording a "consistent interface with telephony, radio". In that sense, the tape acts "as counterpoint to the process of inscription at the foundation of the phonographic regime"[246].]

Magnetic storage in *latency*, poses a challenge to the familiar cultural concepts of memory and recall, confronting it with a radically non-human eventality of storage instead. Here, all

[245] See Theodor W. Adorno, Nadelkurven, in: idem, Gesammelte Werke, vol. 19: Musikalische Schriften VI, Frankfurt/M. (Suhrkamp) 1984, 525-529

metaphorical comparions with Marcel Prousts *Recherche du Temps Perdu* in literary studies fail. The communication and memory technologies applied in Beckett's various works do not simply function as "supplement" and "prosthesis" of a reduced corporeal memory[247], nor is it simply its escalation, but emerges in autonomous, rather auto-poietic techno-logics. Its circuitry and active electronics does not serve for any anthropological metaphor any more, if media-archaeologically confronted in its signal transducing potentials (instead of cultural re-familiarizing).

One the one hand, magnetizable tape only originated in the 1920s from exeperiments with metal dust filters for cigarette paper in early 20th century Dresden by Fritz Pfleumer who actually called it "singing paper". Poulsen's wire-spool based Telegraphon, though, has been presented at the Paris World Fair 1900 as telephone call recording and answering machine. The magnetic wire-based telephonic voice recorder has not been invented for autobiographical memory but for asynchronous communication in a delayed present. The point of transition from the present to the past is undefined. With its "rewind" and "fast forward" buttons as the very affordance of the reel-to-reel tape recorder, the option of time-shifting is already suggested[248] For circus artist Katja Nick the live magnetic recording on stage, after pressing the rewind button, served as a proof of her skill to speak backwards.[249] From a reverse perspective, this implies that Katja, when back-speaking, was in machine state herself.

[Further back, in 1820 Hans Christian Ørsted did not "invent" but rather *discovered* the electro-magnetic effect. This paved the way for Michael Faraday’s experiments with electromagnetic induction in 1831, which ultimately lead to Oberlin Smith's co-originary design of magnet recording almost contemporary to the Edison phonograph, and Valdemar Poulsen's magnetic recording on wire with his Telegraphon in 1898.]

On the other hand, "in the future" as seen from 1959, Krapp's magnetophone will already have been out-dated by the digital audio recorder. When staged in the present age of ubiquitous computing, a reel-to-reel tape recorder on stape appears "antiquated"[250]. But the computer was already contemporary to KLT in 1959, with its computational experimentation in "poetic" text generation by cybernetic informational aesthetics.

In media archaeological terms, there is no technological anachronism in KLP. Magnetic voice recording on steel wire spools originated with Poulsen's *Telegraphon*. is original description deserves a close reading since the real drama media-theatrically unfolds, already anticipating all subsequent cultural aesthetisations. The "technical description" is a literary genre in itself: archaeography dis-coverings the technical essense, transforming it into verbal expression, thereby from electro-mechanics or electronics into techno-*logos*. By magnetizing a monochord-like wire with a passing electro-magnet in the rhythm of microphonically transduced

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[246] As expressed in "Tape: Or, Rewinding the Phonographic Regime" (3–24) by the editors of Twentieth-Century Music 14/1 (2017) special issue *Tape: Or, Rewinding the Phonographic Regime*, Andrea F. Bohlman and Peter McMurray, 8

[247] Lommel 2006: 81

[248] See Murray / Bohlmann (eds.), tape issue, Twentieth Century Music xxx

[249]See her autobiography: Durch "Rückwärts" vorwärts, Berlin (Wiesjahn) 1997

[250] Becker 1998: 162

alternating current of human speech, what remains on steel is "eine Art von magnetischer Wellenschrift", "eine dem Gespräch entsprechende sinusoidale Permanenz"[251] - with the human voice being transformed into a non-human time (resp. storage) signal. In reverse replay, the technical "System" acts as resonyfier "wie eine elektromagnetische Maschine, deren Wechselströme im Telephon in Schall umgewandelt werden" (ibid.). The human mind implements a communicative intention into vocal articulation, which is transduced into a signal apt for the storage channel, and reverse. In Shannon's diagram of communication *engineering*, there is nothing human inbetween, in the essential *medium* event of sending/storing and receiving/remembering.

The communicative relation between Krapp as present actor on stage to his magnetophonic voice is telephonic indeed; almost in parallel to Beckett's writing, a film version of Cocteau's play *La voix humaine*; put both human and telephone on stage.[252]

The wire recorder keeps a material (reverse) identity with telephony by wire; the very same wire serves as channel of transmission and as medium for suspended signal storage channel, while with Pfleumer's "singing paper", the magnetic tape roll rather induces the scissor practice of cut-ups (known from film editing).

Finally, with Digital Audio Tape (DAT), the magnetic tape becomes a hybrid: both analogue (spooling continuously) and digital (in its time-discrete recording of acoustic impulses representing digital samples). The use of "audio" cassettes for data storage is not intended for human senses but for the ears of the machine; it has become prominent for early home computing culture with the Datasette for the Commodore 64 computer.[253]

While Beckett reduced magnetic recording to the human voice and kept the symbolic, alphanumeric regime apart in the "ledger", at the same time, the Z22 electronic computer (Konrad Zuse AG) already applied the rotating magnetic drum for data storage. Since the rotation frequency was still within what is technically defined as "low frequency" band, engineers could experimentally even *audify* such "algorhythms"[254] by directly connecting the magnetic drum to a loud-speaker. Behind Beckett's manifest theatrical application of electro-magnetism, a different media theatre already emerged in the background, epistemologically by-passing the analogue time regime of human voice time axis manipulation by radically non-human, time-discrete data processing. The medium message of KLT has been outdated from the beginning.

What has changed from analog to digital media theatre? Magnetic tape "loops" have been replaced by algorithmic coding of the "if / then" loop. Instead of linear "rewind" / "fast forward" which depends on the materiality of the spool (Krapp's repeated outcry "Spoool" makes him articulate the actual *message* of the medium magnetophone), there are non-linear addresses,

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[251] V. Poulsen, Das Telegraphon, in: Annalen dre Physik, Bd. 308, Heft 12 (1900), 754-760 (755)

[252] See Rüdiger Campe, "Pronto!", in: Diskursanalysen 1: Medien, Opladen 198x

[253] See Bohlmann / McMurray 2017: 20, referring to John R. Watkinson, ‘The History of Digital Audio’, in Magnetic Recording, ed. Daniel, Mee, and Clark

[254] For such a blending of mathematical algorithm with musical rhythm, see Shintaro Myazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012 (http://computationalculture.net)

ccomparable to the rupture that happened between classic celluloid film editing and video "cutting" on AVID)

In an operative sense, drama is machine related, in a performative sense it is body related. Both ratios converge in a definition of Media Theatre which not only extends but transcends human performance with its spatial and temporal constrains to non-human tempor(e)alities - as has already been expressed in Hugo Münsterberg, *The Photoplay*, 1916, as medium-specificity of cinematography against traditional theatrical presence.

Beckett's logocenstrism? The missing machine noise

In true media theatre, it matters indeed whether the materiality (noise) of magnetic tape can be heard as its medium message, apart from the anthropocentric focus of attention to the theatrical voice.

What if, instead of tape loops with analog voice recording, the speech unfolds from within computing in discrete Markov chains? Max Bense has experimented with such techno-mathematical machine articulation in his radio play *Der Monolog der Terry Jo*. In Beckett's radio play *Embers* (1959), the noise of breaking waves at the sea shore figures metonymically for language itself.[255] In contemporary experiments with stochastic analysis in cybernetic linguistics, this metaphor became "literally litteral". Bense's *Monolog der Terry Jo* is based on a sea shore event again: a girl, surviving from a shipwreck, is found without consciousness on the beach; in hospital, she starts to articulate a first senseless, then increasingly meaningful monologue re-telling the trauma. In the sense of informational aesthetics Bense's radio play makes a non-human, bodiless voice speak: A vocoder sonified a computer-generated text consisting of letters with random distribution which increasingly become structered by ordering in Markov chains, to almost semantic patterns.[256]

Repetition and *différance*

In classical drama, presence rests upon two logocentric claims: that is represents human beings with the actual bodies of other human beings, and that it represents spoken words whith words spoken by those actual human beings"[257], while its "reliance on speech rather than on 'dead' writing gives it an immediacy which the novel [...] can never match" (ibid.). In KLT, the very iterative possibilities brought about by the tape recorder undermines the phonocentric claim. Different from symbolically coded notation, magnetic recording operates on the signal event level which is always a time-signal, thereby "temporal object" in Husserl's sense), in fact

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[255] See Joachim Becker, Nicht-Ich-Identität. Ästhetische Subjektivität in Samuel Becketts Arbeiten für Theater, Radio, Film und Fernsehen, Tübingen (Niemeyer) 1998, 124-127

[256]See Hans-Christian von Herrmann, Schreibmaschinenströme. Max Benses Informationsästhetik, in: Wladimir Velminski (ed.), xxx, 2009, 52-61 (59 f.), on Max Bense (with Ludwig Harig), Der Monolog der Terry Jo, in: Klaus Schöning (ed.), Neues Hörspiel. Texte / Partituren, Frankfurt/M. 1969, 57-91

[257] Steven Connor, Samuel Beckett. Repetition, Theory and Text, Oxford / New York (Basil Blackwell) 1988, chap. 6 "Presence and Repetition in Beckett's Theatre", subchapter "Voice and Mechanical Reproduction", 126-139 (126)

"the acoustic materiality of the words themselves"[258] - not as "words", but as sound, which can rather be spetrographically captured in its elementary frequency components, that by abstract alphabetic letters. There is no fusion of the written and the spoken, but rather an unbridgable gap between symbol and signal. The ledger that Krapp consults in order to get a symbolic order into the continuous loops of the spools "forms an interesting counterpoint to the spoken voice that he hears on tape"[259].

Resulting in what Murray Schaeffer once termed "schizophonia", the tape-recorded voice, in replay, dissociates Krapp from himself, resulting in the tempoReal abyss which opens in the differential iteration. Still, the mechanism of the magnetophone induces Krapp to recover his past by temporal shifts and allows, by its button-based forward and backward options, typewriter-like operations. Both movements fuse in the turingmachine. The "endless" tape loop designed by Poulsen around 1900 for his magnetic wire-based voice recorder is written and read by "Schreib-" resp. "Lesemagnete" (758, Fig. 5) actually prefigures the turingmachine indeed.

Lessness

Media archaeology is not just nostalgia for "dead media" electronic hardware like obsolecent magnetophone recording. It has a mathematical cutting edge as well. After Beckett, in his one-act piece *Krapp´s last tape*, had dramatized the recursivity of language related to magnetic tape memory, his equivalent to Max Bense's radio play *Der Monolog der Terry Jo* has been his short (non-)story *Lessness* from 1970 which can be deciphered (rather than hermeneutically "understood"), read and decoded computer-philologically with mathematic methods. Its description itself assumes mathematic form. "*Lessness* calls on 166 lexical items in its first half and not a single new one in its second half; furthermore, it displays <...> a compositional procedure which would allow it to extend its length almost inifitely without drawing on new items. Words 770-1,538 of the text turn out to be nothing but words 1-769 in a new order. It is this fact which suggests a mathematical approach to the text, an approach not only via the mathematics of indeterminacy, namely probability theory [...]. Is there a rule behind this re-ordering or is it random?" In the best sense of cybernetical aesthetics Coetzee in 1973 applied an algorithm to segment the text and isolate the phrases, with the result "that there is no statistical reason for rejecting the hypothesis that phrases are distributed randomly over paragraphs". The new kind of dramatic time has been the runtime of the FORTRAN program: The total running time on a Univac 1106 has been about 30 minutes.[260]

Irruption of media-traumatic "real" into the symbolical time-order of drama

[With his steam-driven acoustic synthesizer mechanism, research artist Morten Riis at a former Transmediale festival in Berlin, and a subsequent demonstration in the) Media Theatre of Media

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[258] Op. cit. 127

[259] Op. cit. 130

[260] J. M. Coetzee, Samuel Beckett´s *Lessness*: An Exercise in Decomposition, in: Computers and the Humanities vol. 7, no. 4 (March 1973), 195-198

Studies at Humboldt University) staged and revealed a dissonance between perception and cognition, since at unpredictable moments the mechanism collapsed and needed rebooting. Is this kind of media theatre planned accident or true malfunction? Can the real be given its place within the symbolic order, or does it rather occur in the a-dramatic field exclusively?]

["Hörspiel" as an art form in German, the radio play, in the anglophone world is often called "radio drama"[261]. This expression is still oriented at the definition of drama as literary script and in a way logocentristic (orientated at literature), as opposed to a radical medium-centristic (radio-phonic) approach: instead of the word-based radio play the acoustic-based "Schallspiel" which dramatizes the materiality of radio transmission itself - a genuinely media-dramatic approach.[262] But even here the apparent noise is still a controlled one.]

"Realisation" has been the technical term for signal (esp. time axis) manipulation in early electronic music production - different from the symbolic order of the written score. Both tape noise (the magnetic hiss) and vocal asemantics is rather missing in Beckett's KLT script. In Lacan's analysis the trauma frequently takes place in close contact (if not directly) with sonic media: be it the (still inarticulated) voice, the actual noise, the cry.[263] The acoustic dimension of violence had escaped literature for long time: the shapeless "real" of battlefield noise which conquered the soldiers' ears without being expressable symbolically by language or writing. Therefore the acoustic event remained, in its extreme forms, a traumatic ongoing presence, an unarchivable memory. In Arnolt Bronnen's theatre play from 1924 about World War I experience, *Katalaunische Schlacht* a gramophone becomes the protagonist itself which haunts the human actors by a spectral (in all senses) repeatable voice - literally retro-active ("nachträglich" in the psychoanalytic sense).[264]

Very close to Sigmund Freud's comparision of the human mememory mechanism to the magic writing pad (*Wunderblock*) and its subsequent psycho-analysis, it requires a new kind of philological source critique (media "forensics" in terms of Matthew Kirschenbaum[265]) indeed to identify the machine as co-author of the media-theatrical drama. The so-called Magnetic-tape-viewer allows for techno-monumental philology (Eduard Gerhard) by making the identification of manipulations on tape such as re-recording, overwriting, erasure, cutting impulses and splicing, even the original recording machine, possible.[266]

Depending on the technical configuration, the wire recorder (Poulsen's *Telegraphon*) or the

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[261] See Tim Crook, Radio Drama. Theory and Practice, London / New York 1999

[262] See Rudolf Arnheim, Rundfunk als xxx Klaus Schöning, Zur Archäologie der Akustischen Kunst im Radio, in: Westdeutscher Rundfunk (ed.), Klangreise. Studio Akustische Kunst: 155 Werke 1968-1997, Cologne 1997, 1-11; furthermore: Richard Kolb, Das Horoskop des Hörspiels, Berlin (Max Hesse) 1932, and Friedrich Knilli, Das Hörspiel. Mittel und Möglichkeiten eines totalen Schallspiels, Stuttgart (Kohlhammer) 1961

[263] An argument by Annette Bitsch, Berlin

[264] See Helmut Lethen, "Der Knall an sich": Das Ohr als Einbruchstelle des Traumas, in: xxx

[265]Mechanism. xxx and the forensic imagination, xxx

[266]On such literally forensic applications, see Christian Koristka, Magnettonaufzeichnungen und kriminalistische Praxis, Berlin (Ost) (Ministerium des Innern, Publikationabteilung) 1968, 9-28 (146 f.)

magnetophone (with its French term *écriture magnetique*) either erases the previous voice recording by new inscription; with neutral magnet erasure, a palimpsestuous, co-present interference still shines through - literally "crosstalk", the technical term.

In 1954 it has been revealed that, in the course of a 1952 of Wagner's opera Tristan und Isolde, featuring Kirsten Flagstad and the Philharmonia Orchestra conducted by Wilhelm Furtwängler (HMV ALP 1030–35), two top Cs were sung for the then elderly Flagstad by the then young Elisabeth Schwarzkopf and edited into the master tape.[267] The recorded indexical real that listeners (apparently) expected has been violated by tape-based processes. A traumatic irritation of human sense of time and cultural memory results from the radically ahuman processuality of technical recording.

Any approach that ties audibility to human performative practice only and not to operative technological media as such is restricting this dimension to evolutionary continuities and soft transformations rather than addressing the hard discontinuities introduced with the arrival of new media.[268]

While most of the prominent interpretations of media-enhanced dramas like Beckett's KLT hold views about the inseparability of cultural practices and new media[269], the arrival of new media can not be reduced to discursive effects but actually induces epistemic choques. Culturally formated ears, "wrapped up in the Symbolic and Imaginary registers, can not hear how audio technologies expose the Real"[270]. It requires the *media*-archaeological ear such as spectrography to reveal such essentials.

In their technological essence, magnetic voice recordings induce a different kind of scientic analysis which is not limited to philology or musicology any more but researches the sub-semantic poetic articulation on the media-archaological level (spectral analysis with electronic measuring media), thus revealing evidence of a different (sub-poetic) kind. The human is not traumatically irritated by phonography any more once technological analysis reveals that human articulation it an artefact itself, resulting from bio-techniqes and a symbolical code called language.

Tape age(s): Time, temperature, entropy

KLT is a drama about ageing. With the human actor *versus* technological agency constellation on stage, the ageing as drama here is incorporated in "two bodies" (Kantorowicz).

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[267] Martland, Peter. Since Records Began: EMI – The First 100 Years. London: Batsford, 1997, 198, as quoted in Twentieth-Century Music 14/1 (2017), 37

[268] See Brian Kane, Relays: Audiotape, Material Affordances, and Cultural Practice, in: Twentieth-Century Music 14/1 (2017), 65–75 (72), referring to W. E., Digital Memory and the Archive (Minneapolis: University of Minnesota Press, 2013), 38

[269] See Brian Kane, Relays: Audiotape, Material Affordances, and Cultural Practice, in: Twentieth-Century Music 14/1 (2017), 65–75 (73, note 24)

[270] As paraphrased by Kane 2017: 73, referring to Friedrich A. Kittler, Gramophone, Film, Typewriter (Stanford, CA: Stanford University Press, 1999

There is a growing asymmetrie between media time (the tapes which re-play Krapp's voice invariant to temporal progression, whenever it is subjected to the magnetic recorder), and Krapp's biological existence which is subject to aging (that is: entropy).

[The electronic tube, especially the triode, once liberated electro-magnetic media from mechanical constrains, thus from erasure over time; still they are subject to decay over time themselves. "Digital" persistance against entropic time (binary "information") ows its ahistoricity rather to its different form of processing: still signals (recording the physically real acoustic event), but symbolically decoded as information in the mathematical and logical binary sense.]

The magnetic tape is both subject and object of time-shifting. On the one hand, a voice recorded on tape does not age.[271] - a kind of temporal "ekstasis"[272], subverting the accidental phonocentristic tradition. On the other hand, the tape itself is subject to ageing.

In Beckett's drama *Krapp's Last Tape*, the tape serves as material metaphor for a different media-induced temporality. "Metaphor" is not meant metaphorical here in the rhetorical sense but very literally "signal transfer". The technical signal is in principle (*en arché*) invariant towards circumstantial change. Once recorded on a material storage medium, sound is trusted to a technical latency, waiting to come into acoustic existence again by either electro-mechanic or electronic signal transduction.

While Samuel Beckett in his corporeal uniqueness has entropically dissolved (like the successive actors performing Krapp) and symbolically survives rather as a set of alphabetifcally coded texts (his oeuvre), a magnetophone surviving from the original stage event (1958) can actually be re-enacted. Recorded as signals on tape, a "bodiless" voice transcends textual historicity.[273] But what if the magnetic spool itself ages? Tape ageing expresses itself physically: In restoring tape recordings; binder hydrolysis or the "sticky-shed syndrome" cause playback problems associated with certain tape brands[274], contrary to the claim for eternity expressed, e. g., in the trademark of the "Permaton" spool. "[...] A temporary remedy for the problem is to bake the affected tape in a scientific oven at a low temperature for a few hours. Once the tape has cooled for twenty-four hours following the baking process, the tape is able to be played without shedding for about a week before it reverts back to its sticky shed condition. The treatment provides a small window of time for the tape to be safely played for digitization" (ibid.).

[The audio-visual difference]

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[271] Becker 1998: 171

[272] See Günther Stern's habilitation thesis from 1930/31, *Die musikalische Situation*, edited by Ellensohn, xxx

[273] "Da die Tonbandstimmen nicht altern, stehen sie monolithisch außerhalb des organischen und biographischen Zusammenhangs." Becker 1998: 171

[274] Steven Weiss, "Tapes on Open Reels: Tia Blake at the Southern Folklife Collection", in: Twentieth-Century Music 14/1 (2017), special issue "Tape" (eds. Andrea F. Bohlman / Peter McMurray), 149–151 (150)

In Beckett's drama the magnetic tape reels still keep an indexical, analog relation to the biophonically recorded voices of the protagonist who rewinds them on occasion of every successive birthday.

In KLT, the main (human) actor gets lost in the actual loops of his audio-taped autobiographical memories. The medium specificity of Beckett's one act drama depends on the audio magnetophone for his diary-like voice recording, not - as experimented in a recent performance - with his video image recording. In 1958 (KLT), the US Ampex company had just begun to produce an apparatus for television image recording. Analog video has been a technical extension of magnetic sound recording. Would Beckett's drama have been *written* differently in the subsequent age of video tape recording, replacing audio by video, as actually performed in a production of the Schloss Neuhardenberg Foundation, *première* 1st June, 2007?[275]

A television adaption of KLT has employed a flash-back technique for the scene with the girl in the punt, and in a London production "video-tape was substituted for sound-tape and multiple television screens for the single tape-recorder."[276] From a media-archaeological point of view (which is a process-oriented ontology of the internal technological event), though, what appears discontinuous for human audio-visual sensing, is simply two emanations of one technology. Video image recording has been directly derived from the acoustic tape recorder; video artist Bill Viola actually defined the electronic (video / TV) image as an iconic sensation of implicitely "sonic" one-line scanning.[277]

[The Picturephone, as developed by the Bell Laboratories after Second World War, enabled both vocal and face-to-face immediacy over distance.[278] When the signal comes from video tape, this tunnels temporal distance as well - with no communicative feedback channel, though.]

How to re-enact KLT today

As a very literal media-archaeological challenge, there "remains" the preservation of original reel-to-reel tape machines from previous performances of the drama for contemporary enactment. This challenge is familiar from preservationof early media arts as well, such as Peter Weibel's installation *ichmasse-masseich*. Its re-installation in 2012 by-passes the human figures. It still positions authentic magnetophones and a tape loop, but the "ICH" emenates as digitized sound from the off, resulting from computational space rather than the electro-magnetic sphere.

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[275] With Josef Bierbichler, under direction of B. K. Tragelehn (Schaubühne Berlin)

[276] James Knowlson, *Krapp's last tape*: the evolution of a play, 1958-75; *online* http://www.english.fsu.edu/jobs/num01/Num1Knowlson2.htm. See same author (ed.), Samuel Beckett, Krapp's Last Tape. A Theater Notebook, London (Brutus Books) 1980

[277] "The Sound of One-Line Scanning", in: xxx

[278]Mara Mills, The Audiovisual Telephone. A Brief History, in: Henry Keazor / Hans W. Giessen / Thorsten Wübbena (eds.), Handheld? Music Video Aesthetics for Portable Devices, Heidelberg (ART-Dok) 2012, 34-47 (43)

In Simon Emmerson's muscial composition *Spirit of '76* (1976), a reel tape machine has been applied to create an accelerating tape delay; the effect is achieved by letting one of the two reel tape machines drag an empty tape spool around the performance floor. "Although the sonic effect of the delay can easily be reproduced with digital means, such as a Max/MSP patch, the theatrical effect or the sliding spool gets lost."[279]

What really happens inbetween the human voice and magnetophonic recording: "carpentry" as media-theatrical research

Did Beckett care about the technical details, or rather limit his poetic imagination to the resulting phenomena? Neglecting the function of Krapp's bananas in KLT, media archaeology rather focuses on the microphone and the scene of the voice-tape-coupling. The human voice creates vibrant pressure on the microphone membrane which converts the acoustic wave into an electric signal by varying the magnetic field of an iron core wrapped around by a wire coil. In the magnetophone, the electromagnet receiving this fluctuating voltage magnetizes the metal oxide particles glued to a celluloid band of tape. From that moment, the metal particles in their polarisation keep the alternating voltages of the sound signal and can be converted back (after electronic amplification) into acoustic waves emenating from the loudspeaker without being erased themselves (like the ephemeral nature of spoken language). In sharp contrast to the invasive phonographic recording, this does not make an imprint on a material[280]; in addition, the magnetic tape is "biased" with a high-frequency signal immediately before the actual low-frequency voice recording in order to improve the signal-to-noise ratio (dynamics) - which means that there is (implicit) "radio" in magnetophonic audio recording.

Once coupled to such a signal recording and reproducing machine, a human becomes subject to inhuman media time. "A machine" (like the magnetophone) "with superior technicality is [...] an open machine that also assumes humans as interpreters and organizers - this is what is called a 'technical ensemble'. Humans may [...] be mediators in a machine's effort to connect and in that sense become part of the machine's operations"[281], Ina Blom paraphrases philosopher of technique Gilbert Simondon, whose *Du mode d'existence des objets techniques* has been published in Paris (Aubier) in 1958[282] - the very year of KLT's première.

Media-archaeological research, parallel to historical studies in the textual record archives, needs to know the machine behaviour of the apparatus Beckett actually experimented with and applied in the world première of KLT in 1958. When Krapp is handling the apparatus, it is its very resistance which reveals its technicity in the sense of Martin Heidegger's "hammer" argument in *Being and Time* (1927). In moments of failure, the medium changes from its "ready-to-hand" status into the "present-at-hand" mode - which is called "carpentry" in Ian

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[279] Composer Sebastian Berweck in his dissertation: It worked yesterday. On (re-)performing electroacoustic music, submitted to the University of Huddersfield for the degree of Doctor of Philosophy, August 2012

[280]Blom 2016: 160

[281] Ina Blom, The Autobiography of Video. The Life and Times of a Memory Technology, Berlin (Sternberg Press) 2016, 26

[282] 2nd ed. Paris 1989, 12 f.

Bogost's object-oriented *Alien Phenomenology*.

Listening to the magnetophone with media-archaeological ears

Micro-temporal media archaeology with its conceptualizations of non-human media, memory, time and sound objects can be paired with object oriented ontology and speculative realism indeed, both experiencing and exerimenting with the various temporal processes unfolding within technology, letting media themselves become active archaeologists of insight and knowledge.

What do human ears hear when they listen to a recording of a voice on tape - the voice or the magnetized particles of the tape and the impact on the sound by the channel of storage or transmission which alters the signal in nonlinear ways? The development of recording and reproduction technologies has always been media-phenomenally oriented at the human ear as destination. In terms of Shannon's communication diagram, though, the technical communication between sender (transducer or encoder) and receiver (demodulator / decoder) is an internal technical coupling *inbeween*, in the *eigenwelt* cut off from human or natural environment. Different from the human ear which only reacts to acoustics, the electronic apparatus has a sense for implicit sonicity (like in Walter Benjamin’s world the camera eye has access to kind of an "optical unconscious"[283], just like Dziga Vertov's concept of the *kinoki*).

The tape machine itself does not care about acoustics, it is not interested in the coupling of electrical signals to vibrating sound waves in air. It cares about what magnetic coating the polyester tape consists of, the speed of the capstan drive, Dolby and DBX filter curves, and Resistor-Capacitor time-constants - a line of thinking that subscribes to the latest developments within the object oriented philosophy.[284]

Therefore media archaeology investigates the notion of memory and time from the point of view of the tape recorder, in an attempt to locate the "ears of the machine", which opens the possibility to get closer to the actual physical operational technology itself.

The tape is covered with domains of randomly oriented magnetic fields, but when the material gets magnetized by alternating current the domains are swung from their random distributed positions into analogous wave forms.
While KLT focuses attention on the human idiosyncacies and failures of memory and recall, since the presence of a human actor on stage attracts the phenomenal attention from the "audience", the real techno-drama of forgetting is within the magnetophone itself where effacing magnetic memory is the basis of the tape recording itself. The first agency which the revolving tape meets is the erasure head with its function to eliminate all previous intended or accidental previous recordings - unless this is intentionally preserved, in a different circuitry, for palimpsestuous dubbing. Its capacity to manipulate auditory content electronically centers around its three tape heads - erase, record and playback - each containing an electromagnet having the ability to convert an electrical signal into a magnetic force that can be stored on the passing magnetic tape, and conversely convert the magnetic content of the tape into electrical

[283] See Walter Benjamin , A Short History of Photography, in: Screen no. 13 (1) / 1972, 5-26

[284]As expressed in Morten Riis, Where are the Ears of the Machine? Towards a sounding micro-temporal object-oriented ontology, in: Journal of Sonic Studies, https://www.researchcatalogue.net/view/219290/219291

current. In most devices the record and playback heads are combined into one, allowing for immediate auditory monitoring.

While Beckett stages the drama of remembrance, forgetting and repetition in KLT as a symbolic mechanism, actual forgetting and recording takes place within the magnetophone itself, in its magnetization and erasure operations.

Only such "tight coupling" (Fritz Heider 1926) between a human voice and a sonic technology constitutes real "media theatre"; the micro-dramaturgies are governed by techno-logics itself, be it analog electronics or digital algorithms.

The media-archaeologic momentum is the transsubstantiation of the voice in its becoming signals on magnetic tape. The media-epistemic "event" is the momentum of transduction (German *Kontaktstellen*) where the pick-up inductively follows the phonographic groove; the focus of media-archaeological investigation is the tempor(e)ality of *operative* media. No simple translation takes place here (like in "language"), rather a transsubstiation from mechanical movement of the record player (direct impression of sound waves) into electro-magnetic signal latency; immediate (sensual) *Schall* thereby becomes simply a function of a manifold oscillating regime (even in the optical Laserdisc "reading"). Technical *transduction* converting acoustic waves into electric voltage and its magnetic storage still preserves a transitive relation, while digital sampling and quantizing radically disrupts the physical signal into informational *bits* which are rather decoded: "reading" again.

One passage in Beckett KLT remembers: "We lay there without moving. But under us all moved, and moved us, gently, up and down, and from side to side." This poetic memory of Krapp on a boat with his women, spoken and re-played as an auditory diary entry on magnetic tape, actually reflects the acoustic wave forms and the movement of the tape on spool itself - the way signal recording media challenge human perception of movement and stillness, turning it upside down, transforming continuous movement into quantifiable frequencies (since chronophotography).

Techno-traumatic silence

The last remark in Beckett's script declares: "KRAPP motionless staring before him. The tape runs on in silence"[285] - which is Bergsonean *durée* in its purest form, against which engineers developed the auto-stop.

[This coincides with a techno-dramatic silence induced by the final remark ("End of recording") in the protocols of cockpit conversations preserved on magnetic recording from the "Blackbox" in airplane desasters, where one of the two components (next to the Flight Data Recorder FDR which registers the machinic "communication") is the Cockpit Voice Recorder CVR for all kind of semantic and non-semantic speech and noise in the cabin. The doubly protected CVR -Blackbox contains, in the USA since 1966, a 30 minute magnetic tape loop which erases itself after each turn. Both FDR and CVR are additionally provided with a submarine ultra-sonic sender which emits signals after a possible crash for 60 days for location.[286]]

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[285] KLT 1958 / 1965: 20

[286] See Malcolm MacPherson (ed.), The Black Box, New York (Quill / William Morrow) 1998

It has been Becket himself who introduced a dramatic change into his media scenario. At the very end of the 1969 Berlin Schiller Werkstatt production of KLT (and subsequent productions in Paris and Royal Court Theatre in 1973): "Instead of the curtian closing on a motionless Krapp, staring in front of him with the tape running on in silence, Becket had both the stage and the cubby-hole lights fade [...], leaving only the 'eye' of the tape-recorder illuminated. This change, 'originally an accident - heaven sent' Becket wrote, accentuates a theme and contributes to an effect that is fundamental to this play [...]".[287] While the literary scholar does not further take care ot the technical details, media archaeological analysis pays full attention to it. The "eye" is apparently the "magic eye", the oscilloscope-like indicator of the signal dynamics, a vacuum tube which is the only point where the inner electronics of the machine (apart from the mechanic input / output and spool-winding knobs) pierces through, interfacing the outer and the inner world of media theatre, a metonymy of the theatre curtain itself opening and closing.

Loops, analog and / or digital: *Krapp's Last Tape* and the *Halteproblem*

Paradoxically, the magnetic tape which is meant for memory recording, by its very spool time-figure has an inherent "sense of ending". Turing's algorithmic finite automaton is based on the (purely theoretical) assumption of an infinitive, endless, never-ending storage *tape* for intermediary notation.

Its loop structure is characteristic of the classic magnetic tape (reel-to-reel); "loop forever" reminds of Samuel Beckett's play *Krapp's Last Tape* (first performed in London 1958) which ends with director's note "tape runs on in silence" - an endlessness which has been answered by technology by introducing the auto-stop mechanism at the end of a tape on spool.

In parallel (and contrasting) to KLT, in digital computing a different *Halteproblem* emerged, as the nondiscursive machine excess to Beckett's biographical drama. The problem in the *Halteproblem* is "to determine, given a program and an input to the program, whether the program will eventually halt when run with that input. Beyond Krapp being lost in magnetic tape loops, iterative procedures and fractal recursions have become the predominant *chrono-tropes* in computing time. To express it in pseudocode: "else loop forever".[288]

SONIC "PRESENCING" AND TECHNOLOGICAL VOICING OF THE PAST

Analysis of the "sonic"

"But what is a historic present if not a present that can be successfully archived?"[289] What has not been recordable in alphabetic writing (even if symbolically intended but the explicit introduction of single letters representing vowels in the early Greek alphabet[290]) is the physics of the voice which can be recorded only in the gramophonic signal. "What defies literary

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[287] Knowlson, referring to Beckett's personal letter to J. Knowlson, 18 May 1972

[288]See https://en.wikipedia.org/wiki/Halting_problem, accessed 21st March, 2018

[289] Doane 2002: 105

[290] See Ernst / Kittler (eds.) 2007

memory is approachable only by means of nonliterary media."[291]

While the present has been considered an inevitably ephemeral, uncapturable time momentum for the longest time, the human voice especially has embodied and allegorized this "fugit tempus" experience of presence. An early newspaper article announcing the invention of the gramophone disc by Emile Berliner starts with the remark that volatile speech has finally been "imprisoned" by the new recording technology, making it not only repeatable for aesthetic or bureaucrativ used, but accessible to scientific speech analysis on a micro-level of formation which - different from the human physiological options of memorizing delayed presence - only measuring media can capture, register and thus keep for time axis manipulations. On the darker side of this widening of research topics for humans, with this option goes the traumatic experience that the voice can be preserved as a "dis-embodied" event. Thus it has got into the focus of communication engineering, psychoanalytic and historiographical analysis, particularly in its capacity to engender a sense of heightened presence (as compared with written records).

Audio signal archives emanate from chrono-technical recordings; their specific feature is the power of "re-presencing" (Vivian Sobchack) the sonic event.[292] Sonicity affects and irritates human time consciousness.

Husserlean and Aristotelean time: Sonic "rhythmograms" vs. discrete clocking

Sound being understood as time signal event opens access to a plurality of nonnarrative temporalities which even subverts the apparent cultural-historical context of sound perception, production and consumption.

An early advertising for the Bulova Accutron Space View watch announced "The Tick vs. the HUM". But even if "the hum" sound is smoothly "analog" and thereby coincides with human world experience and the notion of the "flow of time", the mechanical "tick" is (as remarked by Fourier) just an extreme discretisation of the very same vibrative event.

The rhythms which structure perception in the human brain can not immediately be consciously perceived.[293] Therefore a direct sonification of alpha waves in the brain is required. Subjective time sensation occurs apart from the "clocked" time of the Newtonean universe (for classical physics) and "breaking news" (in broadcasting media). Media archaeology as method couples Husserl's diagnosis *tightly* with technological and archival knowledge. "Data Retention" in fact is a term precisely known from static storage within the computer to ensure that the data in an elementary cell will not be altered. The Static Random Access Memory (SRAM) must be supplied by a power supply that will not fluctuate beyond plus or minus five to ten percent, in order not to disturb the elementary cell and to ensure that it will correctly keep the data. "In that case, the SRAM is set to a retention mode when the power supply is lowered,

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[291] Pinchevski 2012: 156

[292] For a discussion of Janet Cardiff's audio walk *Her Long Black Hair* (2004) as aural re-presencing, see Barker 2012: 20

[293] "[...] nehmen wir diese messbaren Signale mit keinem unserer Sinne wahr": Hinterberger 2005: 284

and the part is not longer accessible."[294]

The central terms in the Husserlean phenomenology of the "inner" time sense, retention and protention, is subjective in an objective way: both neurologically, technologically and epistemologically. Predictive calculation has been the central temporal figure which gave birth to what was soon to become popular under the name of "cybernetics" which, as the eponymous Norbert Wiener frankly admitted in the introduction to his seminal *Cybernetics* of 1948, originated in the necessity of World War II anti-aircraft artillery to anticipate the immediate future moves of enemy planes for computing the point in space and time where both the anti-aircraft gunshots and the enemy aircraft meet: "[...] that missile and target may come together in space at some time in the future."[295] This mathematics becomes media technology with the necessary implementation of pre-emtive calculation into a servo-mechanism which performs negative feedback correction of its on-going positioning of the artillery gun in *real-time*.[296]. This "window of the present" is time-critical in its most deadly sense and thereby does not that much refer to "live" transmission of radio signals but rather to "life" in its limited time span in combat. Together with Julian Bigelow, Wiener was involved in the "investigation of the theory of predicitons and of the construction of apparatus to embody these theories"[297].

There is a specific "sonic" temporal quality of the present which is always already instantaneously transforming *passing* (French *passer*) into *past* (French: *passé*). Only with phonographic recording, such a presence becomes repeatable, thus an experience of enduring presence. The age of storability of voice and sound has already created its very retro-action: Sergiu Celibidache as concert director was radically opposed to phonographic "conservation" of music; he favoured the "now".[298]

The alternative to acoustic communication which is periodic propagation of continuous waves (which itself, as frequency reversal, turns out to be countable) is the "digital", discretizing approach: Aristotle in book IV of his *Physics* (219b 1-2): *touto gar estin ho chronos, arithmos*

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[294] Integrated Circuit Engineering Corportation, chap. 8 (SRAM Technology), 8-4 = Smithonian - The Chip Collection (http://smithonianchips.si-edu, accessed May 2014)

[295] Wiener 1948/49: 11. For a different approach to the same challenge see Claude Shannon's involvement in the Cold War Nike anti-missile-program, as reported in Axel Roch, Claude E. Shannon. Spielzeug, Leben und die geheime Geschichte seiner Theorie der Information, Berlin (gegenstalt Verlag) 2009

[296] Wiener describes the "mechanico-electrical system which was designed to usurp a specifically human function - [...] the execution of a complicated pattern of computation [...] the forecasting of the future": Wiener 1948/49: 13 (quoted here after Becker 2012: 226)

[297] Norbert Wiener, Cybernetics. Or control and communication in the animal and the machine, New York / Paris (Technology Press) 1948/49, 13, quoted here after: Rainer C. Becker, Black Box Computer. Zur Wissensgeschichte einer universellen kybernetischen Maschine, Bielefeld (transcript) 2012, 226

[298] Thilo Hinterberger, Kommunikation mit Signalen aus dem Gehirn, in: Barbara Könches / Peter Weibel (eds.), unSichtbares. Algorithmen als Schnittstellen zwischen Kunst und Wissenschaft, Bern (Benteli) 2005, 262-285 (284)

kineseos kata to proteron kai hysteron.[299]

Frequency *versus* oscillation recalls "duration" in Bergson's sense.[300] There is a remarkable "timelessness" (the Nietzschen "eternal return of the same") in periodic processes which can be addressed as frequencies, as demonstrated with one's perception of the movement of a pendulum clock. When visually following the dial of a clock, nothing is left of the past positions.

A tuning fork, coupled to an electro-magnetic coil (as developed by Hermann von Helmholtz in reverse functionality as electro-mechanic device to measure the micro-temporal run time of nerve impulses[301]), provides the time base in the Bulova *Acutron* watch. The stroboscopic microscope is able to visualize the movements of a tuning fork-based clock developed by the Bulova company.[302]

"The kind [sc. of clocks] that tick work on balance wheels, hairsprings and wachtworks. And that's what can make them work wrong. The Accutron timepiece <...> hums. (Musically, between E and F but above Middle C). Accutron opertes on the precice vibrations of an electronic-powered tuning fork. Each vibration splits the seconds into 360 equal parts and Bulova can guarantee accuracy to within on eminute a month. That's am average pf 2 seconds a day."

In digital computing, this is matched by the Japanese *Parametron* based on resonant circuits.

A sine tone here serves as time-giving media event - not for acoustical or even musical sake, but in implicit sonicity: the tempor(e)ality of sound which is shared by processual technologies. The second-indicator does not visibly move abruptly like in the escapement-driven mechanical clock, but almost moves continuously - just like above the haring threshold of ca. 20 hz the human mind can not discreminate between discrete acoustic impulses any more but perceives a continuous tone, even it this tone still consists of oscillating waves (sine / cosine, discretely passing the "Nullpunkt"). Here, two kind of realities overlap: the media-archaeological and the phenomenological one.

Electronic media tempor(e)ality: "acoustic space" (McLuhan)

The wall painting created by René Cera, Pied Pipers All (1969), for McLuhan's seminar room at the university campus in Toronto[303], in an almost psychedelic manner unreveals the television

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[299] See as well Arist. Phys. II, 192 b 21

[300] The concept of "rhythm" as interlacing of both discrete (digital) and continuous (analogue) termporality is discussed in Ikoniadou 2014, 7 f.

[301] See Helmholtz 1863

[302] See http://www.richardkunze.de ("Faszination Stimmgabeluhren")

[303]For a colour reproduction see fig. 3 in: Peter Bexte, xxx, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (eds.), McLuhan neu lesen, Bielefeld (transcript) 2008, 323-xxx (331). Photo: Derrick de Kerckhove; *online*: http://www.greatpast.utoronto.ca/GalleryOfImages/VirtualMuseumArtifacts/PiedPipers.asp (accessed September 2nd, 2014)

image as an implicitely sonic event. On the figurative level, the line-wise unfolding of an electronic TV (half-)frame is linear in the phonographic sense (John Logie Baird's "Phonovision", Bill Viola's "Sound of One-Line Scanning"), while in terms of the sublime ground (broadcasting by electro-magnetic waves), whatever becomes apparent as visual content on the TV tube, the tempo-real message of electronic media is "acoustic" in McLuhans sense of a simultaneous chronosphere.[304]

The sonic is understood here not in its manifest acoustic sense, but as processual ground, thereby akin to electro-magnetic oscillations. Acoustic space is simultaneous and superimposed instead of time-linear, and above all, it resonates: "Resonance is the mode of acoustic space."[305] Through resonance in a physical - not symbolically coded - system, micro-events can cause distant objects to communicate - close to time-tunneling and Tesla-like energy transfer.

Sound is not just mechanical attacks, vibrations to the ear or aesthetic pleasure for the brain but addressing the human (pseudo-)sense of temporality. The true message of sound as event is processual time. There is no actual organ for the "sense" of time in humans but only substitutes and equivalents like the hearing organ which is most sensitive to micro-temporal changes of pattern and rhythm. The sublime temporal infrastructure of electronic culture (with its de-materialisation and instant signal transmission) has triggered the reentry of the category of "sonic" as vibrational event. Even if it is not accessible as acoustic content in human perception, its essential message (its simplicit sonicity[306]) is its temporal form.

The remarkable affinity between sonic temporality and frequency-based technical media time is rooted in time-critical moments: First on the level of sonic performance and technological operativity, and second in the a-historic *momentum* of experiencing time in listening and in experiencing presence-generating devices (chrono-phenomenological *aisthesis*).[307] Sound is transient. German *verklingen* expresses the dying-out of sonic events ("unsounding"). Musical articulation always had to take place in time, as a temporal unfolding; even John Cage's composition for piano *4'33* minutes of silence is chronologically defined (with its first public performance with David Tudor at the piano counting time without playing any tone).[308] In a McLuhanite sense, the acoustical channel itself thus becomes the message.

Martin Heidegger's use of terms from the sonosphere does n o t refer to explicit acoustics (as

[304]See Erik Davis, Acoustic Cyberspace. Talk delivered at the Xchange conference, Riga, November 1997; *online* http://www.techngnosis.com/aco. Published in: Rasa A mite / Raitis A mits (eds.), Acoustic Space - net. audio issue, Riga (E-LAB) 1998

[305]Marshall McLuhan / Bruce Powers, The Global Village. Transformations in World Life and Media in the 21st Century, Oxford et al. (Oxford University Press) 1989, paperback edition 1992, 6

[306] See W. E., Sonic Time Machines. Explicit Sound, Sirenic Voices and Implicit Sonicity in Terms of Media Knowledge, with a Preface by Liam Cole Young, Amsterdam University Press (series *Recursions*) 2016

[307] On "the ontology of vibrational force" and "microsonic turbulence", see Steve Goodman, Sonic Warfare. Sound, Affect and the Ecology of Fear, Cambridge, Mass. (MIT Press) 2010, 81-84

[308] See John M. Cage, Silence. Lectures and Writings, xxx (Weleyan University Press) 1961, 8

physical sound event), but rather to the implicit, epistemological meaning. He made use of sonic vocabulary as a substitutional way of expressing the microtemporal structure of the "event" of being.[309] The "tuning of the world" (as expressed by Murray Schafer in 1977) is a *timing* of the world as well. What looks physically acoustic is temporal in its subliminal affect. If the "sonic environment" is extended to so-called Hertzean waves as well, electromagnetism turns out as sublime temporality in all ways.

The unfolding of "acoustic space" is not linear, but reverberating. McLuhan once called it "echo land" - which is micro-temporal folding. When taking the metaphor literally, acoustic echo implies delay, the very temporality induced by the medium as channel of signal transfer which once led Aristotle in his treatise *Peri psyches* to deal (media-)philosophically with the "Inbetween" (*to metaxy*). By turning the adverb into a noun, after its translation by medieval scholasticism this became *medium*. Therefore the very term media stems from sonic analysis.

Notwithstanding his confusing electricity and electronics, McLuhan thereby made a crucial discovery about the intrinsically "acoustic" structure of electronic mediascapes which are rather defined by temporal relations to each other than by spatial ones.

The affective immediacy of electricity is the reason for traumatic subliminal effects in human perception; this makes the time-critical difference to the world of traditional print culture which, as McLuhan analyzed in his days already, "<...> is threatened, not by anly single factors such as television or radio, but by the electric speed of information movement in general. Electric speed is approximately the speed of light, and this consitutes an information environment that has basically an acoustic structure."[310]

Acoustic signal presence (wave form) differs from the present digital instant (impulse coded as bit). If signals come simultaneous from all directions this corresponds with the structure in the act of *hearing*. But very media-archaeologically, McLuhan's identification of the essence of electronic media as "acoustic structure" evidently refers to an epistemological ground, not to the acoustic figure of what ears can hear. This ground-breaking took place with the collapse of Euclidic space into Riemann spaces and culminates around 1900 with quantum physical notions (the para-sonic wave/particle dualism, up to the "superstring" theory of today) on the one side, and Henri Bergson's dynamic idea of matter as image in the sense of vibrating waves and frequencies on the other side.[311] McLuhan's "acoustic space" is oscillating time and implicitely re-turns in Gilles Deleuze's Leibniz_inspired "interval" philosophy. Less philosophically, it actually happens within algo-rhythmic media.

Therefore the message of the sonic is not limited to the audible at all, but a mode of revealing modalities of temporal processuality - which requires media-archaeological auscultation like with an epistemological stethoscope.

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[309] Rainer Bayreuther, "Phänomenologische Grundlegung" einer Disziplin, in: Heidegger-Handbuch: Leben - Werk - Wirkung, ed. Dieter Thomä, Katrin Meyer, Hans Bernhard Schmid, chapter 2.2 "Auf dem Weg zu einer Akustik des Seyns": 'Stimmung', 'Schwingung', und 'Harmonie' nach Sein und Zeit", Stuttgart / Weimar (Metzler) 2013, 509-512

[310] Marshall McLuhan, letter to Barbara Ward, 9 February, 1973, published in: McLuhan 1987: 466

[311] Henri Bergson, Matter and Memory, London (George Allen & Unwin) 1950, 276

But the digitally modulated (PCM) electrosphere of today differs from this radiosonic (AM) metaphor; its musicality consists of rhythmic impulses rather than continuous waves. With digital numbers, central characteristics of what McLuhan diagnosed as the Gutenberg Galaxy of print culture[312] have returned, thus bracketing the age of analog electronic (mass) media as a interplay of modernity. In a dialectric synthesis, mobile digital telecommunication is now combined with the characteristics of "acoustic space" which is the instant. According to Marshall McLuhan's *Media Log*, "[s]imultaneity is related to telegraph, as the telegraph to math and physics."[313] But this discrete simultaneity is of a different kind. The Internet consists of techno-mathematical topologies rather than electromagnetic waves (even if the electromagnetic sphere survives as channel of wireless data transmission). "Now, Internet 'radio' isn't radio; it does not exploit the spectrum, and that is a big difference"[314] - just like the difference between recording in vinyl grooves and its Compact Disc inscription where its close analysis reveals bit streams which allow for information theory, thereby: mathematical intelligence to control the event of signal storage and transmission. This happens in sublime manipulation on the micro-temporal level. Even if according to the Nyquist / Shannon Sampling Theorem human perception might not even notice the difference between a high definition analog television image and its digital equivalent, ontologically this image has transformed into a different time-object once the critical perspective of the "receiver" is not humans but technologies themselves. But digital data processing which absorbs time to calculate always lags behind live transmission which allows for a different presence.

„Presence“ in audio technology

By software-based motion tracking it can be micro-analyzed that the performative motion anticipates the actually unfolding tone sequence which corresponds to Husserl's notion of the "time window" of melodic presence in neuronal pro- and retention.[315]

Different from the originality of a work of art in photographic reproduction (as described by Walter Benjamin), the *aura* of physical sound can remain intact in its essential feature which is temporal integrity even if converted into the digital code. If by physical modelling matter can be algorithmically reproduced, but movement and sonicity - thus not loosing its tempAURAl quality.

"Presence" in sound engineering is the term for the degree of clarity in instrumental and vocal sound, which can be increased by use of the Equalizer within the frequency ranges of around 18 Hertz to 16 kHz. "In an amplifier, a presence control controls 'presence'. A presence control boosts the upper mid-range frequencies. Thus by increasing the presence with the presence control, the sounds of voices and such instruments seem more 'present'."[316] Remarkably, the audio-technical term *presence* is attached to the voice (or instrument) here. The voice is perceived as indexical testimony of presence on the one hand, and its irritation (subverting

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[312] Marshall McLuhan, The Gutenberg Galaxy, Toronto (University of Toronto Press) 1962

[313] Marshall McLuhan, Counterblast. 1954 Edition, published by transmediale.11 Berlin (in cooperation with Gingko Press) in 2011

[314] Davis 1997

[315] See Rolf Inge Godøy, Marc Leman (eds.), Musical Gestures. Sound, Movement, and Meaning, London / New York (Routledge) 2010

testimony) on the other when re-played from phonographic recording.[317]

"On television production studio's sound desk, there can be several presence controls, for several different, switchable, frequencies. <...> If the degree of mis-match between microphones is great, simply increasing presence is not enough, and instead a sound engineer will use a graphic equalizer, sometimes several, each connected to an individual sound channel"[318] - an operative diagram.

„Presence controls can also be found on electric guitar amplifiers. The first presence control on a Fender amplifier <...> appeared in 1954 on the Twin. [...] The original Fender presence control acted upon the amplifier's negative-feedback loop." <Wikipedia ibid.>

Signal run-time as acoustic media archaeology

There is a privileged affinity between "the larger gestalts of auditory temporality"[319] on the phenomenological level and the processual being of technical media. Here, time-critical moments parallel the most frequency-sensitive ("rhythmic") sense organ within the human which is hearing.

If a movie camera or projector is driven manually like in the vera early days, it turns out the visual perception is much more tolerant to slight temporal deviations. This is different with auditory signal replay. Let me illustrate this by a short audio-visual argument produced by the Media Archaeologal Fund at Humboldt University:

A symbolic order such as the musical composition, being a conceptual diagram, is ideally invariant towards shifts on the time axis, while the historicity of sounds depend on its material embodiment. "Is the sound of an existing Roman era bell dating from the third century a more ancient sound?", the artistic media archaeologist Paul DeMarinis asks. "For this to be the case we would have to think of the bell itself as an encoding of some 'sound'; that sound, in turn, would have to include the splashing of the molten brass, the beating by smiths' hammers etc. But the sound the bell produces in its current use is far from being a recording of these sounds" - rather co-originary sonic production.[320]

Phonographic "engraving" on the contrary is sound in latency. The ontological status of recorded sound is waiting to be activated (German "in-Vollzug-Setzung"), that is: to become

[316] From the online encyclopedia Wikipedia: http://en.wikipedia.org/wiki/Presence_%28amplification%29; accessed September 3, 2013. See Rudolf F. Graf, entry "presence control", in: Modern Dictionary of Electronics, Newnes 1999, 586

[317] See Doris Kolesch / Sybille Krämer, Stimmen im Konzert der Disziplinen, in: same authors (eds.) 2006: 7-15 (7)

[318] Wikipedia op. cit.

[319] Don Ihde, Listening and Voice. Phenomenologies of Sound [*1976], Albany, NY (State University of New York) 2007, 87

[320] Paul DeMarinis, According to Scripture [*2002], in: Ingrid Beirer / Carsten Seiffarth / Sabine Himmelsbach (eds), Paul deMarinis. Buried in Noise, Heidelberg (Kehrer) 2010, 247-252 (247)

medium. This corresponds with the Heideggerean "being-in-time". "Heidegger does not mean by essence (*Wesen*) *what* something is, but how it comes to presence (*wesen*, a verb)."[321]

This can be correlated with the temporal "window of present" of sonic experience which itself corresponds with micro-temporal actions within both primary physics and derived technologies.[322] The conflict between the physically impossible ideal sinus wave in Fourier Analysis and its transient *momentum* as an actually physically performed tone epistemologically resonates.

While traditionally acoustic elements have been symbolically ordered in time ("music"), on the micro-temporal level Fourier analysis identified sound as an event of superimposed (sine) tones itself with its individual frequencies . "Die Trennung 'akustischer Vorordnungen' *im* Material und 'musikalischer Ordnungen' *mit* diesem Material müßte dann aufgehoben werden."[323]

The sonic present

In electronic epistemology, what looks like a particle is in fact a high frequency motion, mathematically expressed by the wave equation. The concept of *micro-tones* corresponds with micro-temporalities in the media-archaeological sense. In fact, "tones" are in the frequency realm what is the reverse of a time function (the sonic wave).[324]

Discrete Cosine-Transformation encodes complex, time- or space-variant signals into a series of discrete frequency components. "They can be added together to reconstitute the original signal during decoding. Nearly all video codecs transform spatially extended images into sets of simple frequencies"[325] - a form of implicit "sonification", and thereby time-critical: "This allows them to isolate those components of an image that are most perceptually salient to human eyes" (ibid.). At first glance this "sonification" appears counter-intuitive: "In what way can a videoframe be seen as a waveform?" (ibid.). A notion of implicit sonicity emerges: the emancipation of sound as temporal form from physical acoustics.

"Sound is not static, it is first and foremost vibrations, and secondly it is friction that causes sound to be heard"[326] - the friction between different physical elements. This is *actually*

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[321] Kathleen Wright, The place of the work of Art in the Age of Technology, in: Martin Heidegger. Critical Reassessments, ed. Christopher Macann, vol. IV: Reverberations, London / New York (Routledge) 1992, 247-266 (264, note 2)

[322] See Joachim Klose, Die Struktur der Zeit in der Philosophie Alfred North Whiteheads, Freiburg i. Br. / München (Alber) 2002, 358 ff.

[323] Karlheinz Stockhausen, Die Einheit der musikalischen Zeit, in: Dieter Schnebel (ed.), Karlheinz Stockhausen. Texte zur elektronischen und instrumentalen Musik, Bd. 1, Köln (DuMont) 1963, 211-221 (214)

[324] See Curtis Roads, Microsound, Cambridge, Mass. 2004

[325] Mackenzie 2008: 51

[326] Tisha Mukarji, Auscultation (2009); http://www.sonicthinking.org/auscultation.html; accessed February 16, 2010

embodied in the piezo-electric effekt, when a voltage is applied to a crystalline surface and induces a shock wave.

In McLuhan's sense, "acoustic space" - beyond the age of printed knowledge - is characterized by its non-fixity - "[v]ersatile and vibrating thoughts that do not rest to stay [...]." High-technological media share with sound its mode of existence-in-time: they exist only in sonorous performance respectively technical operativity. Therfore media analysis non-metaphorically applies sonic terms such as echo, resonance, vibrato, reverberation.

Another form of sonicist investigation is "to examine the pauses, the rests, and the silence". Different from cultural poetics and aesthetics (John Cage), technological silence signals a differential articulation. Speaking a silence, or letting silence speak, is practice in communication engineering since telegraphy and type-writing (and printing) with the empty "space" key. In the binary alphabet, the "off" counts as much for information as the "on". Thus speaks media-archaeology.

Micro-archiving sonic presence with technologies

Technical recording of sound is a process of storage. "The breaking of the time constraint has profoundly changed the nature of acoustic communication."[327] The temporality (and volatile being-to-death) of sonic articulation which hitherto could only by recorded symbolically by mnemonic notation is transformed into space and visualization by the very act of recording, making it available for analysis "outside of time" (ibid.). The temporal essence of sound is thereby turned into a reified, objectified time object, from evanescence to the ob-scene.

The traditional sound record - like the textual record - can be included within an institutional archival frame. With digital sound, though. literally every bit of sonic articulation becomes part of a generalized "archival presence", since a) every digital signal processing involved ultra-short quasi-archival intermediary storage and b) every sound "bit" becomes numerically addressable and thereby accessible to mathematical, algorithmic manipulation. The archival frame is deconstructed and re-turns from within the digital archival records themselves. From analog to digital "archiving" sonic presence, "the manner of storage determines the kind of control that can be exercised over it" - from manipulation to distortion.[328] At the same time, the analog-to-digital conversion results in a transsubstantiation of the audio signal: from the primary physical event to information which is essentially neither energy nor matter. Thereby the signal loses its indexical trace; transitive transduction is therefore to be set into quotation marks: "[...] the digital 'transduction' process includes the digitalization of the analog signal by the ADC, its <micro->storage and / or manipulation in binary number format, and its reconstruction as an anlog signal by the DAC"[329] - which is the conversion of an electronic representation (embodiment?) of a number stored in the computer memory to discrete voltage steps at fixed time intervals (D*t*). The physically continuous original waves are thus transformed into quare waves; in fact every binary computational act is an abrupt form of oscillation between zero and one in a time-sequential form. Only by smoothing the square wave by filters the wave becomes continuous again.

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[327] Barry Truax, Acoustic Communication, Norwood, N. J. (Ablex) 1984, 117

[328] Truax 1984: 119

[329] Truax 1984: 139

Sonic Media Tempor(e)alities: From Analog to Digital

The primal scene (Freudean *Urszene*) of affective irritation of "presence" has been the moment when the human voice which has represented the most transient articulation of presence for ages (since Plato's criticism of writing until the deconstruction of occidental logo-centrism by Jacques Derrida) phonographically could be stored and re-played even beyond the dead of the voice-bearer. The working assumption of the Berlin Team research is that Edison's invention of 1877 which allowed for not just symbolical (phonetic writing in vocal alphabet) but physical (the acoustic signal) recording of the dis-embodies individual voice has been a cultural shock which - although it soon became part of everyday sound culture - has still not been digested within the cultural unconscious. What seems natural to an animal (the notorious dog Nipper listening to "His Master's Voice" at the gramophone tube) for humans leads to a traumatic dissonance between cognitive knowledge (the historicity of the recording) and neuro-physiological affect which perceived the gramophonic voice as pure presence (Dolar).

When the father of *musique concrète* in Paris Pierre Schaeffer defined the acousmatic[330], he re-used a term once coined to describe the teaching method of Pythagoras who concentrated ("heated up", in McLuhan's terms) on the human audio channel of communication by hiding behind a veil (or in a cave) while speaking. This acoustic purism is truly archaic in the media-archaeological sense: letting the pure, disembodied voice emanate while the sound-generating human or machine is hidden. For the listener it is undecidable whether there is human presence, radio transmission or a gramophone record behind the veil. Thereby the visual absence of the sound source does not only refer to space but to temporal irritation as well. An ongoing (even apparently accommodated) paradigmatic shock took place since the invention of the phonograph (and the answering machine), when all of the sudden the voices of the dead could be heard again in re-play: acousmatics in (flat, close to the present, or deep, "historically" distant) time. In addition, there is an additional micro-temporal dimension of acousmatics. Irritation of acoustic perception takes place even when a corresponding visual source can be noticed but is not synchronized with the acoustic event (well known from problems in lip synchronisation in sound film).

The voices and sounds emanating from such a black box are radically bodyless, resulting in a different timing than the symbolical historio-graphical time. This split between an original sound and its electroacoustical recording results in what R. Murray Schafer called "schizophonia" - a dissonance between the affective and the cognitive awareness of sound-based time consciousness.

A special emphasis is put on the analysis of the digitization of "sonic" media archives in its wider sense - with "sonicity" here being used in a neo-logistic way as a category of time-related objects of knowledge, referring to the range of time-based media which are sonic in the sense that electro-mechanical and high-electronic operations share with acoustic events their radical temporal condition. While archives of visual evidence (photography, cinematographic frames) represent a static archive (endurance), the "acoustic space" (McLuhan) of recorded sound and electric circuits stands for processual temporalities. While on the level of user interfaces the digitization of sound sources from the analog archive is mostly unnoticed in the everyday media practice, it is of utmost importance to point out the deep rupture which

[330] Pierre Schaeffer, Traité des objets musicaux, Paris (Seuil) 1966, 91

sublimely takes place when qualities like anlog "live" transmission is being replaced by "real time". Such calculations create ultra-short intermediary archives which look like presence in the narrow time window of what physiologically counts as presence. In addition, the authenticity of the indexical signal is challenged once it gets processed digitally. Acoustic experience within that context serves as a privileged field for analysis. Ironically, by analog-to-digital conversion ("sampling") the symbolical code (previsously represented by the textual alphabet, or musical notation) returns in mathematical forms (alphanumeric algorithms), asking for a refreshed grammatology of the theory and practice of "archiving presence".

Digital sampling troubles the human ears by making it a player in the sonic *imitation game*: "Drum or keyboard sounds stored on a digital music computer can be triggered by analogue recordings. <...> a 'real' drummer, playing with human imperections, can be made to sound like a machine. [...] this technique has been consolidated into a piece of hardware called *The Human Clock* - a triggering device that enables a drummer to drive machines in synch, according to a varying human tempo."[331]

This results in irritations "between human and automated rhythm", culminating in a metaphysics of the analogue: "This sense that analogue is warmer and more natural than digital also extends to its visual signification, <...> signified via the words we use to describe these patterns - *waves* as opposed to *numbers*"[332] - or pulses. *Presence* is<t> "crucially, a *musical* as well as an iconographic term."[333]

Digitization of "archived presence" does not only requiry a very close reading of its impact on micro-temporal operations but might result in a re-definition of the *Archive in Motion* itself.[334]

The affordance of some types of phonograph / gramophone / magnetophone one the one hand (in the Berlin Media Achaeological Collection) and of software and computing competence on the other (in the Berlin team Signal Laboratory), will allow for the experimentation of these media-archaeological questions and theses.

While mechanical sound recording directly corresponds with (and to) the mechanical vibrations of the Gusle string and the Guslari voice, magnetic recording requires the intervenence or a literally technical "medium" which is the apparatus of electro-magnetic induction. The wire recorder, by its very recording medium (a steel wire), directly corresponds with the telephone line - thus allowing for a kind of direct transmission of recorded songs from storage to presence: "re-storing presence".

The sonic time sense in humans clearly observes what Roland Barthes has analysed for lightning-like momentum (*punctum*) of a photography from the past which (nothwithstanding its intellectual cognitive *studium* which refers to its contextualisation in history) rather

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[331] Andrew Goodwin, Sample And Hold. Pop Music in the Digital Age of Reproduction, In: Simon Frith / same author (eds.), On Record. Rock, Pop and the Written Word, London (Routledge) 1990, 258-274 (264)

[332] Goodwin 1990: 265

[333] Goodwin 1999: 269

[334] See Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010

indexially (the chemical fixation of light traces) than metonymically (rheotrical narrative) links the past to the present spectator: "ça a été", the affect of a presence in absence, a kind of negative ontology of presence, resulting in "affective consciousness" when viewing a photography.[335]

Sound pulses human / inhuman: Heart beats as affect of life

The human ear perceives kinetic impulses (the acoustic waves) rather affectively than consciously: "Not because I count `one´ to a tone [...] do I know that I am at the beginning of a measure, but because I feel that, with this tone, I have reached the wave crest and at the same time have been carried beyond it, into a new wave cycle"[336] In current ultra-sonic monitoring of the heart beat of yet unborn humans by cardiotocography, the actual registration sounds like the mechanical rotations of an early Edison phonograph cylinder. An gramophone recording of a human heart beat produced for medical use in 1931, in the German Broadcast Archive (Deutsches Rundfunkarchiv) has been actually catalogued as "Geräuschaufnahme" - as recording of noise.

Media-based figures of time define life as a function of pulsating rhythms. Not the technical frequencies are being evoked (that would be electro-magnetic radar pulses) but human presence as represented by heart beats - imprisoned in many senses. The human heart turns out to be an archetypal case of the acousmatic dispositive; while it can heard it can not be naturally seen. The chest has to remain closed in order to constitute a space of resonance for the heart beats.[337] In a dissimulative disguise of sonic technologies, non-invasive real-time ultrasound imaging in the medical context renders the phantasmagoric impression of actually "seeing" inside the body, while its visuality is a techno-mathematical transformation of ultra-sonic impulse responses. Appropriately, one of the earliest applications of sonic signal transduction into visual representation has been called *Hyperfonografie* in 1942 by the neurologist Karl Dussik.

What literally "counts" here is neither the sonic event nor its imaging procedure, but the run-time of the signal from which shapes of reflecting matter is computationally derived. The mythic nymph Echo becomes media-archaeologically grounded in echokardiography which is based on the impulse-echo-procedure.

The sono-traumatic affect

Presence is no ontological state but an affect of *différance* (Derrida). "Viola's deconstruction of presence leads [...] to the unconscious discovery and experience of time - an essentially traumatic event. [...] This sense of trauma is articulated through the primordial scream that

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[335] Roland Barthes, Camera Lucida, London (Vintage) 1993, 55

[336] Victor Zuckerkandl, Sound and Symbol. Music and the External World, Princeton (Princeton U. P.) 1956, 204f. This argument is being discussed in John Sheperd / Peter Wicke, Music and Cultural Theory, Cambridge / Oxford (Polity Press) 1977, 132ff

[337] See Walter Filz, Herzarchiv. Oder: die Poesie der Dokumente, in: Verein für Medieninformation und Mediendokumentation (ed.), Fokus Medienarchive. Reden - Realitäten - Visionen 1999 bis 2009, Berlin (LIT) 2010, 159-167

recurs throught Viola's work [...]."[338]

Jonathan Sterne writes on the idea of the resonant (phonography-based) tomb, embalming et al. as the discursive condition which gave rise to sound recording technologies: "Phonographic time was the outgrowth of a culture that had learned to can, to embalm, in order / to 'protect' itself from seemingly inevitable decay."[339] It might be added: this was the epoque of studies in thermodynamic entropy as well. This is the discourse-analytic approach, as expressed in the subtitle of Sterne's monography *The Audible Past*: *Cultural Origins of Sound Reproduction*. Under this perspective, recorded voices did not result in a schock but resonated with an already established discursive condition. But even if sound recording apparently results from a discursive setting within a socio-historical context, the probability does not explain the qualitative rupture which resulted from the sudden being-there of phonography.

Different from hermeneutic understanding (German *Verstehen* resonates with its acoustic hearing) Joseph Carl Robnett Licklider researched to which extent speech can be distorted and still remain intelligible: "Distortion is most easily thought of as a deformation of a function of time or of frequency"[340] on the rather microscopic level.

Only with its implementation in physical vibrations, sound as cognitive or symbolically notated "musical" concept starts to haptically affect the human sense of temporal presence. From this material implementation emanates the power of phonographic sound recording media to "represence" (Vivian Sobchack) past performances. Whereas the cinematic format and TV image is always perceived as framed and thus contained (as a kind of distancing quotation mark of reality), the acoustic signal cuts directly, even aggressively into the ear. The radio voice is not perceived as *representation* of the "real" (physically present) but as identical with the human voice itself.

MEDIA TEMPORALITIES AS OBJECT OF KNOWLEDGE (AND THEIR SONIC UNDERSTANDING)

For an epistemological undertanding of technical media

Starting from an *operative* definition of technological media, media epistemology can be specified in its various modes. Against G. W. F. Hegel's critique of machine reasoning a close reading of the specific tempor(e)alities of technologies opens alternatives. Media diagrammatics here replaces traditional history of technology. Technological and epistemological experimenting (with) media time leads to a final focus on *sonicity* as epistemic media object in the dynamic chronosphere.

There is a specific quality of *media* epistemology: Its analysis is firmly rooted within techno-

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[338] Donald Kuspit, Bill Viola: Deconstructing Presence, in: Barbara London et al. (Hg.), Bill Viola: Installations and Video Tapes, New York (The Museum of Modern Art) 1987, 73-80 (78)

[339] Extracts of Sterne 2003 reproduced unter the title "Preserving Sound in Northern America" in: Mark M. Smith (ed.), Hearing History. A Reader, Athens (University of Georgia Press) 2004, 295-318, esp. 308f

[340] J. C. R. Licklider, The manner in which and extent to which speech can be distorted and remain intelligible, in: Cybernetics / Kybernetik. The Macy-Conferences 1946-1953, vol. 1: Transactions / Protokolle, ed. Claus Pias, Zurich / Berlin (diaphanes) 2003, 203-247 (203)

mathematical, that is: material and logical constellations from which inductive sparks of epistemic questions and insights are being derived.

A basic definition of "what is a medium?" starts from the ontological assumption that technologies are *in being* only once they *operate* (processing signals and / or symbols). Media epistemology is thus always rooted in and limited by technological actuality, different from speculations in theoretical physics or purely cognitive philosophy. The case is different for the most powerful contemporary medium: the digital computer.

The specific (a)historicity of media time (epistemology of the technological object)

It is possible to interrelate different layers of technology in recursive ways rather than implying linear development, a non-historicist concept of technological tempor(e)alities. By analyzing and experimenting with technical media, their specific temporality and especially time-critical, micro-temporal processes can be experienced. Media-experimental settings perform "culturalized" knowledge of a secondary nature - with measuring media being the crucial oberserver. A technological setting is an artificial configuration based on cultural knowledge - but still it is of scientific nature, since there are electro-physical laws at work which are not completely dependend on the arbitrary cultural discourse. The media-experimental event can not be reduced to discursive effects. There is always an imminent physical or mathematical "veto" - which is *timing* in terms of recursive algorithms.

From time-based media to media tempor(e)alities

No cybernetic analysis of technology, whether it be analogue or digital, is complete "unless we possess a proper analysis of its appropriate time-concept"[341]. Any media event is a time-based function of signals.[342] Analogous to the way Martin Heidegger once re-shaped the philosophical question from "what is time" to "how is time" (the *shape of time* as expressed by George Kubler) as a processual existence ("eventuality"), media archaeology replaces the ontological definition of media by a dynamic one: media-in-beeing (in allusion to the British military term of a "fleet in being"), its temporal mode of existence. Processuality is the core definition of electro-mechanic and electronic media as such. *Time-based media* in the traditional sense comprise literature and theatre, then grammophone and film. Media archaeology sharpens this notion by focussing on *time-critical* processes as well, i. e. such media, where micro-temporal events are crucial for the overall process to happen at all (synchronization of telecommunication, clocking in computers).

The difference between "time-based" and "time-critical" is itself decisive. "Critical" is meant in the ancient Greek sense - that is, "decisive". In time-critical processes, a whole plethora of temporal figurations are at work, not just the temporal axis as an abstract parameter. Time itself becomes figurative here, a kind of chrono-actor.

The term "media archaeology" sounds like a structural analysis, but - opposed to the

[341] Norbert Wiener, Time, Communication, and the Nervous System, in: Annals of the New York Academy of Sciences, Bd. 50, 1948/50, 197-219 (197)

[342]Karl Küpfmüller, Die Systemtheorie der elektrischen Nachrichtenbertragung, Stuttgart (Hirzel) 1974, 393

archaeological metaphor of "layers" - it is concerned with what is at the essence of technological media: their operative, processual, that is: temporalized mode of existence. Only when being in operation a medium is truly in the medium state; otherwise the apparatus is a piece of furniture.

In 1936 the "invention" of the computer as symbolical machine happened as a by-product of Alan Turing's answer to the problem of the mathematically undecidable: "Computable" numbers are those which are calculabe by *finite procedures*. The question if computer programs have a sense of ending (the *Halteproblem*) leads to the more general consideration of media-induced temporality. Media systems internally develop new forms and operatations of temporal sequences and a different notion of "ending" (recursive functions, real-time operations) and provide of a micro-dramaturgy of synchronizations where smallest bits of time are "critical" for the success of the whole media event.

Focus: Media tempor(e)alities

Technological media are able to address the human perception on its most essential channel of being-in-time (both on the level of neurons and in consciousness). Thus Heidegger's philosophy of *Sein und Zeit* needs to be extended and specified to the question of media tempor(e)alities.

Michel Foucault's archaeology of knowledge remains somewhat letter-centred and thus autopoietically refers to the alphabet-based world and the symbolic order of textual libraries. But "discourse analysis cannot be applied to sound archives or towers of film rolls."[343] With the age of so-called analog media such as the phonograph and cinematography, signs as a function *of* and *in* time themselves can be registered. They maintain not just a symbolical relationship to macro- and microtime (such as historiography), but they inscribe and reproduce functions of time themselves. It is only with the digital computer that the symbolic regime *dia*lectically re-turns: this time in a genuinely dynamic mode (which differentiates implementation of software from the traditional Gutenberg galaxy): algorithmic time, operative diagrams.

What is frequently called "posthumanistic" by now, is very much bound to a critique of historiographical narrative. Thinking based on digital codes directs itself against "'progressive' ideologies, to replace them with structual, system-based, cybernetic moments of thought <...>".[344] This almost Foucauldean discontinuity is what currenty is associated with the rupture between the anlogue and the digital. Post-modern critique of narrative in historical discourse, (inspired by Hayden White's Metahistory[345]) has finally resulted in reflections about alternative ways of writing media-in-time. White has sharpened the analytical attention to early Mediaeval forms of registering events (the Annalistic tradition as opposed to chronicles and historiography proper) which convey a way of experiencing reality not in terms of continuous but in discrete time[346], thus closer to state-based automata with discrete writing/reading of symbols on an endless divine memory tape (which is, of course, the diagram of the Turing

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[343] Friedrich Kittler, Gramophone - Film - Typrewriter, Palo Alto, Cal. (Stanford UP) 1999, 5

[344] Vilém Flusser, Die Schrift. Hat Schreiben Zukunft?, cited in Strohl, Introduction, in: Vilém Flusser, Writings, Minneapolis (Univeristy of Minnesota Press) 2002, xxxiii

[345] Hayden White, Metahistory. The historical imagination in nineteenth-century Europe, London / Baltimore 1973

Machine).

E. R. Clay termed the "specious present" in 1882 for a recent past which is delusively given as perception of the now, different from the obvious past. Every electronic image is already the "halo" of an image (William James), "the dying echo of whence it came to us [and] the dawning sense of whither it is to lead"; such an image (like sound) is always already in transition.[347] New media phenomenology, by combining recent research in neuro science on brain temporalities[348] with the Husserlean definition of temporal experience (pro- and retention), couples technologies with the human experience of affective temporalities.[349] Already Marshall McLuhan's notorious theorem of the "acoustic space" opened the notion of electrified media. In media art like Bill Viola's works the "cinema-digital-video hybrid technique exposes the viewer to minute shifts in affective tonality well beyond what is visible to natural perception"[350]. Let us take this *tonality* literally: There is a sound in electronic media, with the sonic not taken in its physical (acoustic, audible) but in its epistemological sense: being an expression of tempor(e)alities. The privileged relation between sound and technological media is grounded in their analogous time-basedness and chrono-poietical time-basing.[351] New media articulate themselves in symbolically ordered time, which is their media-dramatic musicality.

New options of navigating in archives of audiovisual times past

Once being digitized, the electronic image is open to almost real time access and new search options like similarity-based image retrieval. From this derive options of searching new kinds of archive which are not simply alphabet-based any more but signal-based like phonographic records or the electronic video image on magnetic tape. The traditional architecture of the archive is based on classificating records by inventories. This is being replaced in the digital media by order from fluctuation, that is: dynamic order. But this is an "archive" no more, but algorithmically ruled processuality.

On the borderline of digital addressability, it is possible now to navigate through large amounts of audiovisual data beyond verbal language, an im-mediate access to sound and images,

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[346] Hayden White, The Value of Narrativity in the Representation of Reality, in: Critical Inquiry vol. 7 no. 1 (autumn 1980), 5-27

[347]As quoted in: Bill Viola. Installations and Videotapes, ed. Barbara London, New York (The Museum of Modern Art) 1987, 79

[348] On the neuro-processual time frame ("window of simultaneity") which counts as the human experience of "presence" see Francisco Varela, The Specious Present. A Neurophenomenology of Time Consciousness, in: Jean Petitot / Francisco J. Varela / Bernard Pachoud / Jean-Michel Roy (eds.), Naturalizing Phenomenology. Issues in Contemporary Phenomenology and Cognitive Science, Stanford, Cal. (Stanford UP) 1999, esp. 272f and 276f

[349] See esp. Hansen 2004, chap. 7 "Body Times", 235-268

[350] As paraphrased by Tim Lenoir, "Foreword" to Hansen 2004, xxvi

[351] See Bill Viola, The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (eds.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54. While entries like time, temporality and vision figure prominently in the "index" of Hansen's book, what is missing is the "acoustic", the "sonic", "sound media time".

unfiltered by words. Images and sounds thus become calculable and capable of being subjected to pattern-recognition algorithms. Such procedures will not only media-archaeologically "excavate" but as well *generate* unexpected optical statements and perspectives from an audio-visual archive that can, for the first time, organize itself not just according to meta-data but according to its proper criteria - visual memory in its own medium (endogenic). The notion of „excavating the archive“ in terms of media-archaeology (instead of iconography) is not meant to be a metaphor.[352] What is being digitally „excavated“ by the computer is a genuinely code-mediated gaze on a well-defined number of information patterns which human perception calls "sound" or "images". Contrary to traditional semantic research in the history of ideas, such an audio-visual archive will no longer list sound & image sequences according to their authors, subject, and time and space metadata of recording. Instead, digital data banks will allow audio-visual sequences to be systematized according to genuinely signal-parametric notions (mediatic rather than narrative *topoi*), revealing new insights into their informative qualities and aesthetics.

Epistemogenic things: Listening to the monochord

There are epistemognic things like the setting in a laboratory which is the *dispositif* for knowledge to emanate.[353] In reverse, from a media-archaeological point of view, there is (technologified) knowledge materialized, embedded and implemented within operative media themselves which deserves to be extracted and derivated by explicit academic inquiry and verbalization.[354]

There is, e. g., the *phonisches Rad* as element in the otherwise optically oriented electro-mechanical image transmission Nipkow system.[355] The electro-magnet "phonetic" wheel (inside the apparatus) is meant to synchronize the image lines here between transmitter and receiver - a kind of *tuning* by *resonance*. The sonic is rather implicit here (with no sound to be heard), as implicit chrono-technical sound knowledge (sonicity), while visible tuning here takes place with the stroboskopic disc (attached to the Nipkow disc) which is on the front side ("Interface") visible to the user parallel to the actual television image. The message of the medium process is *timing* here.

When Pythgoras' experiment with the monochord in the 6th century B.C. is re-enacted today, that is: when such a string is mechanically sub-divided and activated, the techno-physical insight of the relation between integer numbers and harmonic ("musical") intervalls which once

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[352] For Michel Foucault, the term archaeology explicitely "does not relate analysis to a geological excavation": Foucault 1972: 129

[353]Hans-Jörg Rheinberger, Experimentalsysteme und epistemische Dinge, Göttingen (Wallstein) 2001; same author, Experiment, Differenz, Schrift. Zur Geschichte epistemischer Dinge, Marburg (Basilisken) 1991, chap. IV "Das `Epistemische Ding ´ und seine technischen Bedingungen", 67ff

[354]This is the special Media Studies training and task within the Faculty of Humanities as different from the engineering and mathematical disciplines.

[355]E. g. the Nipkow-Televizor (30-line), produced by the Tratri Novakove Company in Prague, 1934, on display in the *60 Years of Television Broadcasting* special exhibition at the National Technical Museum, Prague, May-December, 2013)

led Greek philosophers to muse about the mathematical beauty of cosmic order in general is re-enacted - including the rejected experience and deviation of this aesthetic ideology resulting in the "Pythagorean *komma*", that is: irrational numbers. The experimenter certainly is not in the same historical situation like Pythagoras, since the circumstances, even the ways of listening and the psycho-physical tuning of contemporary ears, is different. But still the monochord is a time-machine in a different sense: It lets the present share, participate at the original discovery of musicolgical knowledge, since - in an almost Derridean sense (expressed in his *Grammatology*) - the repeatable *is* the co-original.[356]

In the Italian rebirth of such ancient knowledge, Vincenzo Galilei undertook a number of experiments with a lute to investigate the nature of musical harmonics[357] - a kind of media-based archaeology of the acoustic: "Galilei employed the lute here not as a musical instrument but as a piece of laboratory equipment [...]." Once within experimentation time, it can be re-enacted. On the diagrammatical level, the re-enactment is time-invariant; on the operative level of implementation, the materiality of the medium itself seems to impose certain vetoes rooted in the historicity of the instrument, but in fact, the epistmological operation remains intact in principle (that is: *archaeo*logically): Claude V. Palisca set out to replicate this experiment using a lute built in the 17th century by an unknown maker. "The present condition of the instrument required the use of some substitutions for the mateirals originally used by Galilei in his experiment; however, these did not affect the basis tenets of the experiment."[358]

Once senses are coupled with technological settings, human experience within their autopoietic temporal field, a chrono-regime of its own dynamics (or mathematics, when data are registered digitally). Such couplings create moments of literal ex-ception: Man is taken out of the man-made cultural world (Giambattista Vico's definition of "history") and confronts naked physics.

In Martin Heidegger's late philosophical work, the fundamental notions of *being* (Sein) and *time* (Zeit) converge in the notion of the *event* (Ereignis).[359] In this double sense, the experiment allows a unique experience and at the same time for com/munication across the temporal gap (bridging a temporal distance. In the processual moment of the re-enacted experiment, one shares the same temporal *field* (a notion which implicitely refers to the episteme of electromagnetic dynamics).

Can such experimentation be extended to macro-temporal eventality as well? Experimentation does not give access to historical experience, since past culture can not be re-enacted (except

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[356]Martin Heidegger, Sein und Zeit, xxx, 385: "Die Wiederholung ist die ausdrückliche Überlieferung, das heißt der Rückgang in die Möglichkeiten des dagewesenen Daseins."

[357]As described in: Vincenzo Galilei, A Special Discourse Converning the Unison, trans. in Claude V. Palisca, The Florentine Camerata. Documentary Studies and Translations, New Haven / London (Yale University Press) 1988, 203-205 (Italian text on pp. 202-204)

[358]Claude V. Palisca, Was Galileo's Father an Experimental Scientist?, in: Paolo Gozza (ed.), Number to Sound. The musical way to the scientific revolution, Dordrecht / Boston / London (Kluwer) 2000, 191-199 (195)

[359]See Martin Heidegger, Beiträge zur Philosophie (Vom Ereignis), [= Gesamtausgabe III. Abt. Unveröffentliche Abhandlungen Vorträge - Gedachtes. Bd. 65.], Frankfurt/M. (Klostermann), 3rd edition 2003

in experimental archaeology, maybe). This is the argument of historians usually applied to differentiate their hermeneutic discipline from the natural sciences. Hermann von Helmholtz declares at the climax of historicism in Germany: "Die Beziehung auf die Geschichte der Musik wird <...> auch deshalb nötig, weil wir hier Beobachtung und Experiment zur Feststellung der von uns aufgestellten Erklärungen meist nicht anwenden können, denn wir können uns, erzogen in der modernen Musik, nicht vollständig zurückversetzen in den Zustand unserer Vorfahren, die das <...> erst zu suchen hatten."[360]

But media-archaeological experimentation (simulation as opposed to historiograpic historicism) gives access to the invariant elements of knowledge in time: a kind of "'Experimentalisierung der Geschichte' in Simulationen. Sofern im Rahmen von Medienarchäologie und Simulationstechnologie heute ganze Theorien simulierbar sind, beginnen wir beständig tunnelartige Verbindungen durch die Historie zu graben, wodurch selbst unwägbar scheinende Zusammenhänge erkennbar werden und erforschbar sind. Indem wir aber Zeitobjekte vergangener Zeiten als solche reinstanziieren, läuft das "Wissen von der Musik" immer mehr selbst und von selbst in Musiktechnologie."[361]

On *sonicity*: Sound as epistemic object of (media) analysis

In assuming the epistemological dimension of sonic memorization, the analysis goes far beyond to simply doing justice to *auditory memory* which indeed "has been largely neglected in memory studies in favour of visually-oriented arts of memorization [with their long tradition within rhetoric (ars memorativa)]"[362].

Electronic tuning allows to change a piano's tuning (its "temperament") with ease from universal "equal temperament" to time-specific ratios. "Modern pianos are tuned in ''equal temperament,'' which divides each octave into twelve equal half-steps. The frequency of a note is adjusted up or down, sacrificing some harmony in all keys so none are too dissonant. On the other hand, in many tunings that were popular in the Baroque period, intervals are extremely pure in some keys at the expense of others, increasing the dissonance in those keys.[363] Variable temperaments are essential tune into the earlier *Stimmung* of musical action. Techno-mathematical re-turing of instruments (even in microtones) serves thereby as true media archaeology of the sonic past.

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[360] Hermann von Helmholtz, Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik [*1863], Braunschweig (Vieweg) 1913, 411

[361] Martin Carlé, Geschenke der Musen im Streit ihrer Gehörigkeit. Die antike Musiknotation als Medium und Scheideweg der abendländischen Wissenschaft, in: MusikTheorie. Zeitschrift für Musikwissenschaft, vol. 22, no. 4 / 2007 (thematic issue "Peri mousikes epistemes - Zur Aktualität des antiken griechischen Wissens von der Musik, edited by Sebastian Klotz), 295-316 (313f)

[362]As defined in the call for papers to the workshop *Auditory Memory and Sound Archives from the Late-Nineteenth Century to the Present*, University of Amsterdam, 18 February 2013

[363] Katie Hafner, Piano Tuners Have Built a Bridge To 18th Century, in: The New York Times, published February 17, 2000, http://www.nytimes.com/2000/02/17/technology/piano-tuners-have-built-a-bridge-to-18th-century.html?pagewanted=all&src=pm (accessed July 11, 2013)

"Sing me, Muse, the deeds of a man called Odysseus", Homer's epic starts. What if the Muse is not only reduced to the narratives of "oral poetry" to be registered and displaced in writing symbols which replace (and "technologize"[364]) the oral signal with all its rich overtones (tuning, pitch, timbre, rhythm), but phonographically remembered essentially sonic in itself?

Erkki Kurenniemi is "an unsung" pioneer of electronic art, the back cover (endorsement) of the DVD *The Dawn of Dimi* articulates[365], quoting *The Wire* (January 2003): "Viewed from a historical perspective, Kurenniemi's music foretold digital directions in rhythm, noise and jumpcut editing, only back then no-one was listening." Is there a "historically" delayed listening? Yes and no: not historically (since this cognitive sphere is a function of historiography and the alphabetically recorded and organized archive), and yes: temporally delayed, reminding of the physically given evidence that every "presence" of aural listening already involves the delayed transfer of acoustic vibrations through air with a speed of around 330 meters/sec. - *medium* time in terms of Aristotle's "acoustic" definition of physical media.

Sonic eventality is not only time-based, but in a more radical reading it leads humans to experience time at all. The neo-logism of "sonicity" aims at catching "sound" as an epistemological object of knowledge from a media-philosophical perspective. The audible section of the bandwith of sonicity (acoustic sound) is just the deceptive top of the ice berg above the water level, or comparable (in less "layer" metaphors) to the visible part of the electromagnetic spectrum which animals perceive as "light". *Das Sonische*, a neo-logism in German language (different from *Klang* which is acoustic "sound") in this context refers to the inaudible vibrations ("analogue") and rhythms ("digital") within the electronic field (*Sonik*).

Sound as epistemological form of timing refers to continuous ("analog") vibrational and discrete ("digital") frequential dynamics of all kinds, ranging from the most precise (electro-)physical micro-moment over the human affect of temporal perpection up to repercussions of what traditionally (fixed by writing) used to be called history. But to understand the ways that media inscribe themselves on our bodies, we need a philsophy of time that recognizes the production of a different time-writing. "Before the phonograph, no sound had the option bot the be fugitive. A historical rupture in the nature of sound arises that, in turn, rewrites its entire history."[366] But maybe this irritation is more fundamental: not just a historical rupture, but a rupture of the privileged dominance of historical discourse over the phenomenology of emphatic time as such. The generation of vocal or otherwise sonic "presence" of cognitively known absence induced by the phonograph does not simply ask for a re-writing of media historiography, but requires different ways of writing temporal figurations as such - a kind of archaeography which the oscilloscope making visible sonic wave forms performs for long time already.

Sound allows for the co-experience of transient time and even time-invariant affects. It is this processual experience which the sonosphere shares with high-electronic media. Just like culture tries to save sound itself from its ephemeral temporality, signal recording media for the first time in cultural history mastered the time axis towards arbitrary manipulation.

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[364]In the sense of Walter Ong, Orality and Literacy. The Technologizing of the Word, London (Methuen) 1982

[365]Published by Kinotar Oy and Museum of Contemporary Art Kiasma, Helsinki 2003; Editor: Mika Taanila

[366]Peters 2004: 193

The term "sonicity" does not refer to the apparent phenomenological quality of sound but rather to its essential temporal nature which is its subliminal message behind the apparent "musical" content.[367]

Nicole Oresme's late medieval *Tractatus de configurationibus qualitatum et motuum* defines the "sonus" in its physical materiality as a function of the time axis[368] and thus comes close to the present definition of sonicity as epistemic articulation. The diffuse genealogy of the term *sonus* ranges from the concrete physical materiality of sound up to its epistemological definition[369] for which the neologism *sonicity* might be allowed.

Sonicity refers to knowledge about implicit periodically varying functions of time.[370]

Acoustic sound - in order to be communicated beyond its natural physical limits - must be technically transduced in order to fit to a technical channel such as the telephone line or electro-magnetic radio waves. While passing as transduced signal (voltage-controlled current), sound is in its implicit state.

Volatile sound and speech must be converted implicit in order to pass the channel of cultural time and historical tradition: it must either be signal-recorded in phonography or symbolically coded by musical notation.[371] According to Marshall McLuhan, telephone, gramophone, and analogue radio were "the mechanization of post-literate acoustic space"; in fact: "We are back in acoustic space".[372] McLuhan declared on the climax of analogue electronic broadcast media culture. "Sonic" space is understood here as the epistemological existence of sound, somewhat opposite to the term in physics.

The term "sonic epistemologies" itself is already awry; ancient Greek *epistemé* is already triggered by the visual bias of alphabetic writing (as defined by McLuhan 1962).[373] No. 4 of the Journal for Sound Studies (JSS) is a special issue devoted to *Sonic Epistemologies* which is

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[367]This argument refers both to Marshall McLuhan's central argument ("the medium is the message") in *Understanding Media* (1964) and to Martin Heidegger's epistemology of technology's essence, in: The Question Concerning Technology and other Essays, New York (Harper and Row) 1977

[368] "[...] aliam vero extensionem habet [sonus, et] motus, a tempore, que nunc vocetur longitudo ipsius soni": Nicole Oresme and the Medieval Geometry of Qualities and Motions, ed. by Marshall Clagett, Madison, Milwaukee / London (Univ. of Wisconsin Press) 1968, Book II, chap. 15 *De natura et difformitate sonorum*, 306

[369] See Frank Hentschel, entry "Sonus", *online* www.sim.spk-berlin.de/static/hmt/HMT_SIM_Sonus.pdf (accessed July 2013)

[370]In that sense, John Durham Peters writes of "sonic revelations" of the vibrational qualities of the human eardrum by Hermann von Helmholtz' artefactual resonators (Resonatoren): Helmholtz, Edison, and Sound History, in: Lauren Rabinovitz / Abraham Geil (eds.), Memory Bytes. History, Technology, and Digital Culture, Durham / London (Duke University Press) 2004, 177-298 (185)

[371] See Peters 2004: 188

[372] McLuhan, "Five Sovereign Fingers Taxed the Breath" (1954)

sometimes called "acoustemic" already.

Marshall McLuhan made a crucial discovery about the intrinsically "acoustic" structure of electronic mediascapes. The immediacy of electricity is valued essential as the definite difference to the Gutenberg world of scriptural and printed storage of information: "Visual man is the most extreme case of abstractionism because has has separated his visual faculty from the other senses <...>. <...> today it is threatened, not by anly single factors such as television or radio, but by the electric speed of information movement in general. Electric speed is approximately the speed of light, and this consitutes an information environment that has basically an acoustic structure."[374] Very media-archaeologically, McLuhan's terms "basic" and "acoustic structure" evidently refer to an epistemological ground, not to the acoustic figure in its phenomenological body-related sense.

In an epistemological sense, the sonic is not about (or limited to) the audible at all, but a mode of revealing modalities of temporal processuality, up to the "superstring" theory of today. Already Henri Bergson formulated his dynamic idea of matter in the sense of vibrating waves and frequencies.[375]

"The *message* or effect of electric information is acoustic" (McLuhan) - even when it is perceived as an electronic "image" - as defined by the video artist Bill Viola in his essay "The Sound of One Line Scanning"[376].

McLuhan's "acoustic space" is oscillating time and implicitely re-turns in Gilles Deleuze's "interval" philosophy. But information in "online" worlds come a-simultaneous from topological directions which recalls a different structure of the act of *hearing*. "Sonic" tempor(e)alities unfold on the level of packet switching in the "social net": "Temporalities of flows, bursts, and various techniques and techologies of time management [...] is what characterises the specificity of reproducing existing worlds in network culture."[377]

Listen to how "prosodic" communication in the World Wide Web sonds like on its basic media-archaeological level, its signal clocking in terms of *dactyles*: All of the sudden, one of the oldest figures of prosody in occidental poetic speech returns as implicit sound of digital tele-communication - true *technopoiesis*.

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[373] Tatsächlich führt die Altphilologie das griechische *gignóskein* (das Erkennen eines Gegenstandes als sein Erzeugen) auf den Zusammenhang mit Begriffen des Sehens, des Auges, zurück.

[374] Letter to Barbara Ward, 9 February, 1973, in: McLuhan 1987: 466

[375] Henri Bergson, Matière et Mémoire, Paris 1898; in English *Matter and Memory*, 276: matter = vibration

[376] Bill Viola, The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (Hg.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54

[377] Abstract to Jurri Parikka, Of Queues and Traffic: Network Microtemporalities, lecture at the Glasgow Memory Group symposium *Digital/Social Media and Memory*, April 17th, 2013

Sonic tempor(e)alities

In fact, the sonic ground of the electronic image is "hidden" in the media-archaeological and Heideggerean (*aletheia*) sense: "It is acoustic. It resonates. But this is a hidden ground, because superficially people think they're looking at a visual program. And they're not. They're not looking at all - they're absorbed, involved in a resonating experience."[378] So-called immersion is rather into a *sonic* than visual sphere.

There are two kinds of carrying sound through time: "musical" memory as symbolically notated in scores (the archive) and sonic memory preserved in signal-based recording media (starting with the Edison phonograph) which are endowed with "temporal indexicality" (Thomas Y. Levin). Media temporality refers both to the symbolical ("digital") and the physically real ("analogue") regime - like the clocking of computers and the "Time-To-Live" which in the Internet for data packets decides about the success of communication in virtual, that is: calculated space.

In the world which is experienced by all of us as presence we observe an implosion of the despotic signified "time" into a multiplicity of times and timings in the sense of chrono-poetics.

This time machine (not in the sense of time-travelling, but of time-generating mechanisms) is sonic by nature. The term "sonic" here refers to the two bodies of dynamic tempor(e)alities: the wave form and the digital, that is: mathematically intelligent (algorithmic) manipulation of numerically addressable frequencies.

A "musical" composition (or other code), when effectively, that is: physically, implemented in operative media, is in itself *a priori* already a sonic *Versinnlichung* as temporal affect. In a more advanced interpretation, sound is even a soni*fiction* of time in the strict sense of Latin *fictio*, since it *generates* temporality.[379]

Different from functional sonification as defined by Gregory Kramer as "the use of nonspeech audio to convey information"[380], sonicity is about *implicit* acoustics - like the Pythagorean notion of sound as number[381] which is the "acoustic" in McLuhan's *implicit* audio sense - a processual mode taken as epistemological term.

The present experimental popular music or avantgarde compositions is characterized by an

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[378]Marshall McLuhan, in: Letters of Marshall McLuhan, selected and edited by Matie Molinaro / Corinne McLuhan / William Toye, Toronto / Oxford / New York (Oxford University Press) 1987, 177

[379] See W. E., Chronopoetik. Zeitweisen und Zeit*gaben* technischer Medien, Berlin (Kulturverlag Kadmos) 2012

[380]"More specifically sonification is the transformation of data relations into perceivged relations in an acoustic signal for the purposes of facilitating communication or interpretation": Gregory Kramer et al., Sonification Report. Status of the field and Research Agenda, *online* http://sonify.psych.gatech.edu/publications/pdfs/1999-ns-f-report.pdf (Januar 2013)

[381] See Paolo Gozza (ed.), Number to Sound. The Musical Way to the Scientific Revolution, Dordrecht / Boston / London (Kluwer) 2000

aesthetic multiplicity which extends the limits of human perception to infra- and ultra sound and to micro-temporal events.[382] This pushing of sonic limits is itself a effect of the almost infinitive flexibility of digital technologies. Thus it makes sense to extend the term "sonic" to non-acoustic time-based eventalities: vibrations and their mathematical reversal which is frequencies.

The (h)ear(ing apparatus) is much more sensitive to micro-temporal (time-critical) processes than the eye. While the flickering of an electric bulb (50 times/sec.) can not be noticed by the after-image in the eye any more (the cinematographical effect), the rising of acoustic pitch from 50 to 100 oscillations/sec. is very well perceived indeed.

This hits a deep epistemological dimension. If the experience of being is not a static one (ontologic), but rather processual (being-in-time), then the definition of existence as "being tuned" ("Durchstimmung" with Heidegger) recalls sonic resonance. "Stimmung", in German, relates both to the voice ("Stimme") and to the tuning ("stimmen") of an instrument, and more sublimely, radio reception - constituting "sonic" media temporality.

"In order for one person to understand what another person says, he must be 'in tune' with him. [...] such intrapersonal synchrony is far more fine-grained than that of any *corps de ballet*."[383] Communication, here, is not simply "a function of social context"[384], but of time-critical signal engineering.

In many respects sound – heard, recorded or transmitted – is radically ahistorical; its specificity could not be captured and subsumed by the logocentrism of traditional narrative historiography. Serious engagement with “the sonic” – sound as sound and sound as time – provides access to a plurality of non-narrative temporalities.

CHRONOPOETICS AS "SONO-POETICS". The Appeal of Sound as Time-Object and Time-Subject for Technology-Oriented Media Theory

So what is "chronopoetics"?

Chronopoetics investigates the ways technological media are time objects and time subjects; for that reason, the analysis stays close to the actual signals. In order to perform such analysis, it first needs a cognitive training: to get distance from the discourse of cultural history. Historical discourse is all too hegemonic when it comes to discuss multiple temporalities. The media-archaeological cold gaze and listening (both technical and as human understanding) is a

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[382] On "sonic" time, see chap. 9 "Toward a Media Archaeology of Sonic Articulations", in: W. E., Digital Memory and the Archive, edited and with foreword by Jussi Parikka, Minneapolis / London (University of Minnesota Press, Reihe Electronic Mediations, Bd. 39), 172-183

[383] Alan Lomax / Irmgard Bartenieff / Forrestine Paulay, Choreometrics. A Method for the Study of Cross-Cultural Pattern in Film, in: Ronald D. Cohen (ed.), Alan Lomax, Selected Writings 1934-1997, New York / London (Routledge) 2005, 275-284 (278), referring to: W. S. Condon / W. D. Ogston, Film Analysis of Normal and Pathological behaviour, in: Journal of Neurological and Mental Diseases, vol. 142, no. 2 [Jahr xxx], p. 237

[384] Lomax 2005: 277f

way to get - at least momentarily - suspended from that supremacy of historical discourse.

Media archaeology describes technological events on the level which is phenomenologically hidden to human perception. Here, a micro-drama unfolds, both *in* time and in the form of its diagramatic mathematical expression: the frequency domain. It is only by measuring, diagramatic and calculating media that this world becomes accessible to human knowledge.

Chronopoetics refers 1. to the "hidden" tempor(e)alities with *in* technology, 2. to the phenomenological irritation of human sense of time when being coupled to media timing, and 3. to the philosophical dimension: the revelation of how technical media are position in culturally "deep time".

After getting used to non-historistic ways of rethinking media time, more constructively it takes an active step to develop a new language for the analysis and implementation of such tempor(e)alities. While conventional historiography of technology writes "about" media time (that is, in the instransitive mode), a transitive approach to express multiple media temporalities needs to be developed. Next to non-linear verbal forms of argumentation, that results in graphical diagrams and even sonic rhythmograms - and in different temporal moods of looking and listening to media-induced events.

Rhythmograms and their media-archaeological *Kehrwert*

The theory of music has been the traditional cultural domain to reflect upon different modes of time-based articulation, and has provided a rich terminology for expressing sonic eventality. It is not accedental that in electronics, engineers frequently borrow musical terminology to name time-critical processes - like "resonance" (nd the "resonant circuit" as its hardware condition in technical communication between a radio sender and a radio reception. This allows for a word-play, a slight shift of signifier: from technical *chronopoetics to sono-poetics*. "Sound" is the bridge between technical media and "music" as cultural aesthetics.

The both effective and affective "message" of sound as phyiscal event is not "music" (which is rather its semantic "content") but its temporal form. Therefore the focus of an epistemological inquiry into sound is on its temporal *gestalt*[385]. The "hidden" tempor(e)alities with *in* technology might be coined as "sonicity". This refers to the implicit temporality in electronic media. In mid 19th century, James Clerk Maxwell explicetly chose a mechanic analogy between electro-magnetic field lines and hydrodynamic oscillations and coined this the "electrotonic state"[386].

Sonic signals in terms of mechanics are vibrational physical events with harmonious partial "tones" - literally ancient Greek *tonos*, "tensions". They have a privileged affinity to the epistemological concept of the "analogue". When, e. g., an archaic computer game is emulated in a current computer but was once created for continuous vector graphics on a cathode rays screen, and if the interface on the hardware level has to be a real vector monitor (which can not be convincingly emulated by a matrix screen with its aliasing pixels), the amplifiers of the

[385] "Zeitgestalt" in terms of Zuckerkandl 1963

[386] James Clerk Maxwell, Über physikalische Kraftlinien (1861/1862) [= Ostwalds Klassiker der Exakten Wissenschaften, vol. 102, ed. by Ludwig Boltzmann, Reprint Thun / Frankfurt/M. (Harri Deutsch), 1. Theil, 6

present computer soundcard are being "misused" in order to generate, on the x and y axis, such kind of vector graphics.[387]

Media Studies at Humboldt University once organized a symposium called *Think Analogue!*, juxtaposing the "dead medium" of analogue computing with the electronic modular synthesizer in electro-acoustics - which in fact are twin machines. Among others, media artist Benjamin Heidersberger (co-creator of *Van Gogh TV*, an early experiment in interactive television presented at Ars Electronica in Linz and Documenta in Kassel in early 1990s) projected his electronic Lissajous figures created from an oscilloscope. This is an escalation of what his father - a prominant black & white photographer in post-war West Germany - had photo-mechanically created and called "rhythmograms".

In order to captures the message of Heidersberger's medium, it takes a technology which itself is able to record movement; Ali Altschaffel has cinematographically documented the "Rhythmograph" of Heinrich Heidersberger:

Online https://vimeo.com/89780677

[Heinrich Heidersberger 1959 in Wochenschau http://www.filmothek.bundesarchiv.de/video/589598; min. 7:00 til 7:30, with the second version of the machine]

There is a remarkable, epistemologically challenging equivalence between a mechanical generation of Lissajous figures, and its electronic expression. Though completely different physical systems, their temporal unfolding is principally (*en arché*) the same. Only in mathematical terms this relation between two incompatible worlds (materiality of mechanical devices vs. immateriality of electro-magnetic waves) can be expressed; therefore the real level of epistemological insight is mathematical. The technical medium to perform this is not the digital but the analog computer.

The hypothesis of analog computing is that an electric voltage circuitry can emulate a mechanical process since in mathematical description (as common denominator) it behaves the same.

What one could actually hear in the studio with Heidersberger's rhythmo-poetic machine was not the harmonic oscillations themselves which result from the photographic registering of the light trace produced by the machine movement, but the noise of the machine itself. The visual rhythm emerges by opto-chemical recording: the subject-less long-time exposure of black & white photography. The visual "Rhythmograms" result from the inherent mathematical musicality of a mechanical analog device.[388]

The truly media-archaeological equivalent to Heidersberger's visual rhythmograms are algebraic formulas: differential equations. Only such radical mathematisation resists the

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[387]See Stefan Höltgen, Spiele(n) mit Pfeilen. Computerspiele und Vektorgrafik, in: grkg / Humankybernetik, vol. 56, no. 4 (2015), 143-158 (158)

[388] Heinreich Heidersberger had built "an analogue computer designed for the combinatorial exploration of mathematical phenomena": Andrew Witt, Heinrich Heidersberger. Light Harmonies, Ostfildern (Hatje Cantz) 2014, 11

metaphysical, esoteric or aesthetic seductions induced by such visual wave forms such as *Kymatik* (Jenny).

Heidersberger's "rhythomgrams" continue what in 19th century had started with Lissajous' tuning fork-based figures and later resulted in Heribert W. Franke's electronic "real time" oscillograms.[389]

When in 2014 a selection of Heidersberger's Rhythmograms were re-exhibited[390], the subtitle was appropriately *das gestimmte bild* - the "tuned" image. There is implicit sonicity in such "technical" images. This ontologically recalls Martin Heidegger's philosophical notion of being as "Stimmung", and in terms of media arts has been expressed by video artist Bill Viola in an early essay defining the electronic image as "The Sound of One-Line Scanning"[391]. Heidersberger's rhythmograms are spatial geometrizations of time-continuous oscillations, thereby freezing the sequential into simultaneity.

Marshall McLuhan, the founding father of technological media studies as academic discourse, frequently referred to so-called "acoustic space". This term does not address the explicit audible sound but rather the implicit "sonicity" of technical articulation - the rhythmic structure and temporality of signal processing and algorithmic operations.[392] Any algorithm written down as source code has to become implicitely "sonic", that is: electronically implemented as sequential time events, in order not to remain simply an abstract symbolism but effectively computational. This requires temporal *understanding*.

Contrary to Heidersberger's *Rhythmograms* (produced between 1953 and 1965)Indeed, today's techno-acoustics is rather beat than oscillations, impulses rather than continuous sound, stochastic noise rather than Pythagorean harmonics.

One way to de-metaphorize sound art is its spectral analysis - the analysis of such *temporal* tones as tabular mathematics. This causes vibration <...> to assume a numerical existence, a return to alphabet-based epistemology - a recursion of the ancient linkage between number and "music".

[For the difference between Heinrich Heidersberger's harmonic *Rhythmograms* and early computational drawings, see Frieder Nake's *Achsenparalleler Polygonzug* (1965)[393]]

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[389] See Witt 2014: xxx

[390] *heidersberger: rhythmogramme*, at Petra Rietz Gallery, Berlin

[391] Bill Viola, The Sound of One-Line Scanning, in: xxx

[392] Even in cultural time technology rather unfolds in "resonant intervals" than in straightforward evolution, as expressed by McLuhan in *The Global Village* and his *Laws of Media*. See Ernst Wolfgang (2015) 'History or Resonance? Techno-sonic Tempor(e)alities', in: Journal of Visual Culture, 14 (1), pp. 99-110

[393] In: Justin Hoffmann / Kunstverein Wolfsburg (ed.), Der Traum von der Zeichenmaschine. Heinrich Heidersbergers Rhythmogramme und die Computergrafik ihrer Zeit, Wolfsburg 2006, 24

An academic turn to "sound studies" is currently taking place. But is the focus on "sound" justified for a critical approach to digital media culture? The hart-beat of computing (generating its "clocking") is the crystal oscillator with its piezo-electric effect. No sinuidal oscillations but sharp saw-teeth impulses.

In Homer's epic *Odyssey*, female sirens have been singing, but mechanical sirens (as invented by Cagniard de la Tour) express air pulses rather than continuous waves, discrete signals rather than tones. Only by addresing the sonic time signal in its mathematical form (counting by frequencies), sound can be "heard" by the digital computer. Computational clock time, by clever programming of its data cycling units, becomes truly algo-rhythmic.

Ubiquitous oscillations (Ørsted)

The human ear is especially sensitive to micro-temporal changes of pattern and rhythm. Time-critical signal archaeology is not simply concerned with so-called "time-based arts" (which start with oral prosody and theatre already, leading to film and other mass media dramaturgies) but with *kairotic*, that is: time-critical media technologies.

1803 Ritter writes to Hans Christian Ørsted: "Aller Sinnesempfindung liegt Oscillation zum Grunde. <...> überall, wo nur etwas geschieht, geschieht es auch nothwendig oscillatorisch."[394] Answers Ørsted: "If we imagine a taut string making its slowest vibrations, we are able to distinguish each vibration with our eyes. Let the speed increase, and now we can no longer distinguish one vibration from the other; we see only the entire space through which the string vibrates filled by it. There is a gap between the point where the visibility of the individual vibrations ceases to the point where the deepest tone begins. Now imagine the vibrations proceeding with increasing speed and producing higher and higher tones; in the end the speed of the vibrations becomes too great to be perceived by the ear."[395]

Ørsted further, in 1808: "The vibrations continue to increase, and after an interval like the one between the fastest individuality visible vibration and the lowest tone, the vibrations here will rise to the production of the deepest color. It appears in front of the eye as a faint blue twilight, and with increasing vibrations it clears to higher and higher colors and thus runs through all prismatic colors until they have reached the most vivid red. According to this conception, one sense would become an octave of the other on the grand scale of sensations, and all would be subject to the same laws. Thus all sensations spring from the same original force."[396]

Geometrization of sono-temporal patterns

The central sonic event is the sine wave which in its pure form only exists from technical signal generators like tuning forks or electronic circuits, not in nature - just like sculpture in ancient Greek art idealized the actual human body:

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[394] Quoted here after Siegert 2003: 300

[395] Hans Christian Ørsted, Experiments on Acoustic Figures [1808], in: Selected Scientific Writings of H. C. Ørsted, trans. and ed. by Karen Jelved, Andrew D. Jackson, and Ole Knudsen, Princeton (Princeton Univ. Press) 1998, 280

[396] Ørsted 1808 / 1998: 280

Fig.: Antiken-Oszilloscop

Instead of writing it on a time axis in its continuous wave form, the sine wave can be alternatively computationally.

According to Poincaré, one can divide mathematicians into two types - those with visual and those with auditory intuition.[397] It is the operativity, the inner sonicity of computing which reveals temporal patterns indeed; that is processual media-archaeology. The algorithmic rhythm of digital calculation can be visualized by rectangular versions of the so-called Ulam spiral. In fact, this is no sound-"image" but a time-diagram.

Similarly, the Moiré effect originates from the "pixelized" image by the grid in half-"tone" photo printing (raster). For color raster printing several grids have to be overlaid, resulting in *moirés* which correspond to "Schwebung" in sonic impulse series. The moiré projector, overlaying one stable grid (slide) with a movable second grid (slide), is a sonic composition and device.[398] A temporal sequence is here translated into a spatial order.[399]

The Ulam Spiral is a method devolped by the mathematician Stanislaw Ulam in 1963 for the graphic representation of prime numbers by means of locations on a rectangular spiral.[400] Nikita Braguinski experimented with such data visualization for his Ph.D. thesis on the oblique sounds originating pseudo-randomly from electronic toys and early computer games[401]:

Fig.: Ulam-Spirale-Primzahlen-PASCAL.png, created by Nikita Braguinski

[See Nikita Braguinski, Die Spiraldarstellung - ein experimentelles Visualisierungsverfahren, https://www.medienwissenschaft.hu-berlin.de/medienwissenschaft/medientheorien/miniaturen/braguinski-spiraldarstellung-03.pdf]

The rectangular Ulam spiral representation allows for the visualization of the calculations by

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[397]See Steve J. Heims, John von Neumann and Norbert Wiener. From Mathematics to the Technologies of Life and Death, Cambridge, Mass. / London (The MIT Press) 1980, 128

[398] See Emanuel Goldberg, Die Berechnung der Moiré-Erscheinungen, in: Zeitschrift für Reproduktionstechnik 8, Heft 12, 1906, 189-195, as referred to in: Michael Buckland, Vom Mikrofilm zur Wissensmaschine. Emanuel Goldberg zwischen Medientechnik und Politik, Berlin (Avinus) 2010, 39-42

[399] Wolfgang Coy, Der diskrete Takt der Maschinerie. In: Georg Christoph Tholen / Michael Scholl / Martin Heller (eds.), Zeitreise. Bilder, Maschinen, Strategien, Rätsel, Zürich (Stroemfeld/Roter Stern) 1993, 367-378 (367)

[400] See M. L. Stein, S. M. Ulam, M. B. Wells, A Visual Display of Some Properties of the Distribution of Primes, in: The American Mathematical Monthly, Vol. 71, No. 5 (May, 1964), 516-520

[401] *RANDOM. Die Archäologie der elektronischen Spielzeugsklänge* at Humboldt University, Berlin, February 2016

the digital computer PASCAL from the early 1960s for prime number culculation - which is all about the hypothesis that it might be possible to detect repetitive patterns in an apparent random sequence.

["Am Anfang der Suche, das heißt im Zentrum des Bildes, sind keine Muster erkennbar. Wenig später beginnen sich auffällige Bänder von wellenartigen Mustern zu bilden, die jedoch zeitweise von Rauschanteilen unterbrochen werden."]

The algorithmic procedure in the PASCAL computer in its time could still be sonified by loudspeakers, since the cycling units of calculation were within the low frequency range of the human ear.[402]

Before the introduction of the electronic tube which allowed for calculating with ultra-sonic speed almost devoid of material inertia, electro-mechanic computing was audible in itself, like the 4 Hz clocking of the early Zuse 1 computer.

The misuse of electronic radio vacuum tubes as digital switch resulted in a quantum leap of speed in computing; therefore the first fully electronic digital computer, the otherwise silent ENIAC at Princeton, requires explicit sonification to make it understandable for human ears again.

[as has been performed in the Signal Laboratory of Humboldt University Media Studies by Martin Carlé.]

In the early days of digital computing, technological devices for short-time data storage like the *acoustic* mercury delay line used the slowness of sound waves itself as dynamic storage medium.

So far, the Ulam spiral has been used for the visual demonstration of mathematical regularities. Braguinski proposes the application of the Ulam spiral for signal analysis as well, as an alternative to the usual tools for sound visualization like wave form and spectrogram, with a focus on the idendification of structural regularities or deviations on the micro level.

Looking at such geometric pictures, one may have learned to decipher the implicit sonicity in it. The mathematic construction of a rectangular spiral is step-wise created from discrete elements in succession. Such discrete elements may be the sampling values of any digitized signal, thereby translating (rather than simply transforming) the time-domain into the frequency domain which is visual patterns.

This allows to recognize repetitive patterns in the data output of what is called a random generator; immediately it becomes literally "evident" that what sounds like accidental noise, when being produced by a digital device, can only be pseudo-random.

Spatializations of the time axis for the sake of analysis result in a geometrization. Does this

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[402] See Nijenhuis, W. 1962: Hörbares Rechnen der Pascal, in: Philips technische Rundschau, 24. Jahrgang, 1962/1963, Nr. 4/5, 169-176. See as well Christoph Borbach / Thomas Nückel, Sonifikation zellulärer Automaten = Cellular Sounds Project:

https://www.youtube.com/channel/UCAYWbTbWZ5VimoDLYA1CsDg

deprive the sonic event of its essential message which is time? Is this a re-Pythagorizing of the signal event into a mathematical, "musical" ratio instead of its processual wave event?[403] This is not simply a technological question but a momentum with epistemological dimension. The time function of a sound signal $s(t)$ can only be approximated by the signals of the sample-and-hold operation in analog-to-digital conversion.[404]

Fourier transformation allows for translating the physical "time" signal into the frequency domain which can thereby be numerically addressed and mathematically processed - still being the same signal, having lost all its temporality. Fourier analysis supposes that the analyzed signal is *ideally* periodic, reaching back indefinitely into the past and extending likewise into the future. But once again: The pure sine tone does not exist in phsical reality. Any physical real signal is time-varying, always being characterized by a beginning and an anticipative sense of ending. Analysis can only focus on the time domain or the frequency domain (that is why Denis Gabor developed his time-windowing of sound anlaysis in terms of "acoustic quanta").

[Straightforward Fourier Transform of a periodic sound, by supposing a Platonic ideal endlessness, sacrifices the tempor(e)ality of the sonic signal which is always marked by the trace of its beginning: the *transience* of the signal. There is an existential temporality ("being-to-death") of any physical sonic event in Hegel's and Heidegger's sense. Wavelet-Analysis tries to capture exactly such temporality by slicing the sound.]

Not only the composition of sound is analyzed, but its very unfolding in time is visualized.[405]

Materiality in being: Temporal sonicity of the monochord

Different from the material artefacts of classical archaeology which are preserved in museums, technical media from past times are not simply monuments which survived into the present, but they are essentially "time objects" ("Zeitobjekte") themselves; Husserl's term refers to objects which are not only a "unit in time", but "contains in itself temporal extension"[406]. The techno*chrono*logical object, in the active sense, is not simply subject to historical time, but an active agency in the media-theatre of time. Given the definition that technical objects become media only in the moment they actually process signals, that is: being in operation, then technological artefacts from the past can not be reduced to their materiality but have to be processual. Then they are timing themselves, undoing historical distance, being radically unhistorical. "[T]he vexing relationship between media, time and history can be viewed as variations on one German verb: *zeitigen*. It derives from *Zeit* (‘time’) and is normally a transitive verb followed by a direct object. “*X zeitigt Y*” means “*X* brings forth (or yields) *Y*”,

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[403] See Hermann Gottschewski, Graphic Analysis of Recorded Interpretation, in: Computing in Musicology vol. 8, 1992, 93-96

[404] See Fig. 4-4 in: xxx Görne, Tontechnik, 2nd ed. 2008, 130

[405] Julia Kursell / Armin Schäfer, Kräftespiel. Zur Dissymmetrie von Schall und Wahrnehmung, in: Zeitschrift für Medienwissenschaft 2, 1/2010, 24-40 (32)

[406] Edmund Husserl, On the Phenomenology of the Consciousness of Internal Time (1893-1917), transl. by John B. Brough, Dordrecht (Kluwer) 1991, 24

with the understanding that *X* does so in or over time."[407] Central to chrono-poetical analysis of technology and media culture therefore is the intransitive use: *Medien zeitigen*; "*zeitigen* here means to “time-ize” or “put in time” (2014: 406). [...] To deprive *zeitigen* of its direct object opens up two dimensions of “time-ing” which, taken together, drive a wedge between media time and the time of history."[408]

The archaeological model of an ancient Pythagorean monochord becomes a *media*-archaeological object only when it is activated, that is, when the string is activated. Processual archaeology is not concerned with the human behind the artefact, but with the system embracing both.[409]

Once a technical medium is intentionally activated, it starts to generate complex non-human phenomena, resulting in a media-active drama. Thereby the medium dis-closes its implicite knowledge in time.

Media archeology allows for a *synchronic* perspective or rather listening. As a *method* it concentrates on the functional-operative, processual dimension both in the material and in the theoretical sense. This allows for an archaeology of past media events as "re-presencing" (Vivian Sobchack), resulting in a literally better *mathesis* (understanding) of ancient technological knowledge by retro-active media archaeology.

Short Wave Radio

Even in high-tec electro-magnetic "Hertzean" wave propagation such as radio and television or mobile communication devices, media archaeology rather "listens" to the implicit sonicity of vibrational ratios. The task of a media theoretician now is to find arguments why, e. g., Short Wave radio communication is not an out-dated medium in times of Internet radio, and not just for nostalgics of analog technologies. Short Wave radio reception means listening not only to the actual radio program but as well listening to radio as techno-physical medium (try it, if you have an old reveiver with AM / SW mode), a more media-critical and media-aesthetic transitive coupling of our ears to the technology. With its fading signal strenght and all kind of noisy interference from the ionosphere sourrounding the globe, we become aware of radio in its true sonicity: the structural affinity between technical media and sonic articulation.

Technical recording vs. symbolic transcription

Since Thomas Alva Edison's phonograph, the analogue audio-recording media have built up a signal-based memory of sound which challenges the symbol-based traditional "musical" score as textual archive, recording even the non-musical articulations, the non-intentional, non-semantic evidence of the acoustic event, such as noise or bird-singing in the background which had been rather inaccessable for alphabetic or other symbolic notation. Wax cylinders or

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[407] Geoffrey Winthrop-Young, TS "Timely Matters", 2015

[408] GWY, TS "Timely Matters", 2015, according to suggestion by Larson Powell

[409] Kent V. Flannery, "Culture, History vs. Cultural process: A Debate in American Archaeology, in: Mark P. Leone (ed.), Contemporary Archaeology. A Guide to Theory and Contributions, Carbondale 1972, 105

gramophone records constitute a sonic "counter-archive" (Paula Amad).

Once such recorded signals have been transcribed into the symbolic code, all non-musical (non-harmonic) information is irreversibly lost (unless the phonographic record itself is being preserved for later, unforseen technical "understanding").

From passive archaeological records to active media-archaeology, such signal recordings allow for the electronic measuring of sonic articulation. Instead of the predominance of musicological interpretation which is cultural semantics, this liberates the sonic event to experimentation, enabling a non-hemeneutic analysis on the sub-philological, sub-alphabetic level.

But what has been recorded on analog media is now being re-played from within the computer. With the digitization of endangered audio media, the symbolical order of clocked time sublimely returns within sound itself - which both Bergson and Heidegger denounced as "vulgar" mathematical time, mathematizing the vibrational event.

Sampling and quantizing of acoustic signals transforms the time signal into frequencies as a condition for re-synthesis. Media culture turns from phonocentrism to mathematics. Digitizing analog records equals mathematical sound analysis itself. Hermann von Helmholtz questioned "mathematized" sound on the epistemological level:

"[H]ow can we be sure that what has been proven mathematically also occurs in nature [...]? [...] There is nothing in Fourier's analysis to suggest that it is litte more than a mathematical fiction, 'permissible for facilitating calculation, but not necessarily having any corresponding actual meaning in the things themselves'"[410]]

In fact humans listen mathematically to the continuous sound, with our hearing channel being an implicitely calculating organ since since the inner ear counts frequencies subconsciously (*nesciens*, in Leibniz' term[411]).

There is a priviled affinity between sonic resonance and the experience of past time. Ludwig Wittgenstein once confessed that when he imagined a tune recorded for a gramophone "this is the most elaborate and exact expression of a feeling of pastness which I can imagine"[412] - undoing historicity in favor of a different access to temporality.

[Does the acoustic signal loose its temporal indexicality when being recorded? Binary "recording" on Compact Disc is a punctual temporal moment, while in acoustic recording by gramophone there is a processual time signal. Its re-play generates a different sense of the past. Replicating a sound from a recording medium, even if taken away from the real event, "retains its indexing properties"[413]. As engraved index (in Peirce's semiotic sense) a sound

[410]Helmholtz, *Lehre*, 56; engl. Übers. S. 34 (?); zitiert nach Erlmann 2010, xxx

[411] On the "Zählorgan Ohr" see Georgiades 1985: 42

[412] Ludwig Wittgenstein, here quoted after: Gregory Ulmer, Applied Grammatology, Baltimore (John Hopkins University Press) 1985, 110

[413] Naomi Cumming, The Sonic Self. Musical Subjectivity and Signification, Bloomington / Indianapolis (Indiana University Press) 2000, 90 (unter Bezug auf Charles Sanders Peirces Collected Papers (1.335, 1905)

forms a sharp contrast to its symbolic notation. Sound, when being re-generated out of electro-magnetic latency, embodies a tempor(e)ality different from the almost scriptural engraving in the gramophone groove.[414] The gramophone groove is literally being in-formed by sound, but this is still a material, physical shaping, whereas digital information is no question of matter or energy any more: a sequence of symbols which can be statistically measured in terms of transitional binary entropy, a new kind of "score".]

"First sounds" (Patrick Feaster), "Time(ly) matters" (GWY)?

Phonography "avant la lettre" is understood here in a double sense: first of all, all signal record is pre-symbolical, non-alphabetical, no "letters".

It is the media-archaeological intention to listen to early sound recordings in a non-historical way (anti-hermeneutically). From this archaeological site emanates a geninely signal-based resonance of the past "based on waves and simultaneous time"[415]. It requires something like the "media-archaeological ear" to make knowledge use of that option.

In 1857, the Parisian printer Édouard-Léon Scott de Martinville patented his *phonautographe*. Sound waves would trigger vibrations on a parchment, which would then be transmitted to a stylus which etched out the waves on a page darkened by the carbon of lampblack. Scott designed a pure inscription device lacking any playback feature, since as an expert in stenography his target was that people could and should learn to *read*" the graphic traces left by the mechanical acoustic transduction. Scott recorded sounds, but it did not occur to him "that by retracing the grooves and channeling the vibrations back into a funnel it could also do the reverse. "And read they were, though neither in Scott's lifetime nor by human eyes. In 2009, almost exactly 150 years after the recordings had been made, a set of squiggles was scanned, converted into digital waveform, and played back by a computer. At first, a minor mishap occurred. The researchers engaged in acoustically disinterring Scott fell prey to Kittlerian time axis manipulation." (GWY 2015)

"[T]hey thought they were hearing a woman's voice, singing the French folk song '*Au claire de la lune*,' but later they realized they had been playing back the audio at double its recorded speed. When they dropped it down to the right tempo, a man's voice appeared out of the crackle and hiss: Édouard-Léon Scott de Martinville warbling from the grave."[416]

Today, opto-digital reading of early Edison cylinders allows for listenting again to otherwise unaccessible sound recording; the opto-digital *close reading* of sound as image, though, dissolves any meaningful unit into discrete blocks, which are accessible for human analysis only by operative techno-mathematical diagrams.[417]

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[414] See Theodor W. Adorno, Die Form der Schallplatte [1934], in: same author, Gesammelte Werke, vol. 19: Musikalische Schriften VI, Frankfurt/M. (Suhrkamp) 1984, 530-523

[415]See Tony Schwartz, The Responsive Chord, New York 1974 <?>

[416] xxx Johnson 96, as quoted by WGY, Typescript "Time(ly) Matters", 2015

[417] See Patrick Feaster, Pictures of Sound. One thousand years of educed audio: 980-1980, Atlante, GA (Dust-to-Digital) 2012

The recording which became famous by Internet circulation has been the French song "Au claire de la lune" sung into the phonautograph in 1959. But closer to the medium, the very first recording surviving as phonautogramm in the Parisean archives leads to a moment of indecidability, an irritation of hermeneutic and acoustic understanding: sound or noise? Which is the "first sound" - a recognisable artefact, or a media event?

Audio: Feaster-2012-Ur-Phonautograph-Scott-1857-Track-16.wav

But caution, the record from which sound emanates in such acoustic argumentation is not a disc with acoustic grooves any more but a computer storage disc with discrete data sections which need algorithmic processing to become rhythmic music again.

This is an analytic, media-archaeological form of deciphering the sound of the past. To the media-archaeologically sharpened mind, such sounds from a computer audio line-out will never be confused with a "live" sound since such a mind is conscious of the algorithms of which such an animation is a technomathematical, processual function.

In media-*active* archaeology, the technological apparatus itself turns out to be the archaologist proper. Patrick Feaster and David Giovannoni succeeded in re-sonifying the preserved phonautographic engravings (*Schallbilder*), beginning with Scott's recording of a sound folk tone of 435 Hz in the year 1859.

Here the pure vibrational medium (the sine wave again) is the recorded message, before it became buried and dissimulated in musical "content".

150 years later science realized that with optical "reading" of such acoustic signal lines sound can be re-synthesized and thereby re-sonified.[418]

What metaphorically appears like the pick-up of sound images by a "virtual, digital gramophone needle"[419], in fact is something media-epistemologically different, a picking-up of a completely new kind: the techno-mathematical ear.

True media archaeology starts here: The phonograph as media artefact does not only preserve the memory of culturalized sound but stores past *technical* knowledge as well, a kind of frozen media memory embodied in engineering and waiting to be listened to by media-archaeologically tuned ears. The noise of the wax cylinder itself which the record articulates whenever it is being re-played is not discursive, but media-archaeological information of the physically real event; listening to this attentively does not exclude it by anthropocentric hermeneutics.

With the micro-physical *close reading* of sound, the materiality of the recording medium itself becomes archivally poetical.[420] Instead of musicological hermeneutics the media-archaeological ear listens to signals. The media archaeologist, without passion, does not hallucinate life when

[418] The sonification of Lèon-Scott's phonautogram from April 8, 1860, in Paris (the children song "Au clair de la lune, Pierrot répondit") can be accessed *online* http://www.firstsounds.org/sounds/1860-Scott-Au-Claire-de-la-Lune-09-08.mp3

[419] Harald Haack, Die erste Klangaufzeichnung. Eine Audiografie, *online* http://newsbattery.blogsport.de/2008/05/07/die-erste-klangaufzeichnung-eine-audiografie

he listens to recorded voices; the media archaeological exercise is to be aware at each given moment that we are dealing with technical media, not humans, that we are not speaking with the dead but operative recording keeps sound un-dead.

"Phonographic reproductions are physical effects of the real. A gramophone inscription surface captures sound waves emanating from Enrico Caruso's larynx. "This is not the case when we write about Caruso"[421] - all the difference between transitive signal recording and intransitive historiography.

From "beyond the grave" (Chateaubriand),

"[...] Scott's Parisian recording session is the first undead moment in time. It is the earliest instance of physically recorded history we can directly link back to by means of technologies able to reproduce the recording. Here, media become the subjects of media archaeology by providing a technological link-up that enables us to experience a fully mechanized (and later digitized) Proustian *madeleine* moment: a temporal interface that cuts across time. [...] With the invention of the phonograph, he [sc. Edison] decreed, speech "has become, as it were, immortal" (quoted in Kittler 1999: 21). New media allow us all to graduate to ghosthood; but ghosts are apparitions very much at odds with history. Referring to Edison's phonograph, John Peters notes that it "divides history into two halves, a before and an after. Prior to 1877, all sounds died" (2004: 177)." (GWY 2015)

At that point, let us go even one step further: "Is that which is divided here, especially if it is divided into mortality and immortality, still contained *by and within history*?" (GWY 2015)

"First, technological media record and store" - or steal? - "real time (with, as in case of Scott's almost inaudible voice, all the accompanying noise, crackle and hiss - indeed, the very concept of noise has real-time recording as its technological apriori). This storage of time by means of media technology and its subsequent re-production by later media technologies allows for a direct temporal interface between otherwise distinct moments of *human* time." (GWY 2015)

But is this still a human voice, or does it turn out - resulting from analysis into the nature of speech by nineteenth century measuring and recording media - that the human voice in itself is a mechanical event which can be co-originary produced by synthetic devices?

Any audio recording "takes its own time. Technological media operate in accordance with their inner *eigenzeit* ("own time"), which is categorically distinct from the surrounding human time. "The *eigenzeit* of the apparatus world relates to the macro-time of history like self-referential systems to their so-called environment."[422]

In terms of cybernetical theory, we live in systems of closely or tightly coupled tempor(e)alities.

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[420] Karl Sierek, Die weiße Leinwand, in: ders., Aus der Bildhaft. Filmanalyse als Kinoästhetik, Wien (Sonderzuahl) 1993, 115-130 (122), referring to: Umberto Eco, Semiotik, 263f

[421] Geoffrey Winthrop-Young, Timely Matters. A Story of Media at Odds with History, typescript (November 2015)

[422] GWY 2015, paraphrasing W. E., Gleichursprünglichkeit. Zeitweisen und Zeitgegebenheit technischer Medien, Berlin (Kadmos) 2012, 306

"*Medien zeitigen*, then, implies that operating in their micro-temporal *eigenzeit* media engage in a 'techno*poiesis* of time'"[423] - which is chronopoetics. "They create a piece of technologically facilitated time that can be moved along *outside* of the human time of history and then - with ghostlike effects - be reinserted back into it." (GWY 2015)

Chronopoetics aims at replacing the unifying, totalizing signified "time" by a plurality of tempor(e)alities, as expressed by George Dyson:

"Time as we know it just does not exist in the digital universe. A computer is not operating on time, it just operates on sequence. [...] this other world exists now, and it is not tied to our form of time at all."[424]

ASYMMETRIES BETWEEN SONIC SIGNALS AND MUSICAL MEANING

Is has been the "first order" cybernetic premise that capacities of the human "mind" (less emphatically than its German equivalent *Geist*) can be modelled by logical circuitry (McCulloch / Pitts) and by "learning" automata, as has been demonstrated with the "Perceptron" for visual pattern recognition.[425] This has been developend into "musical" information aesthetics, admitting the problem of machine "creation of valuable, meaningful artificial texts, the aptitude to master a general semantics"[426], based on the "functionalist" hypothesis that non-biological processing of sensory objects are chrono-structurally equivalent (isomorphous) to what is declared "meaningful" by humans, as expressed, e. g., in Turing's paper "Computing Machinery and Intelligence", or in Gotthard Günther's definition of the "trans-classical machine" consciousness[427]. If mental states are analogous to computational states, they are multiply analyzable and synthecisibable, even "in electronic states of robots"[428]. The question of machine meaning has to be preceded by a definition of what is understood as "meaning" - accompanied by the media-archaeological perspective of how the machine looks at human meaning, in reverse simulating artistic creation such as by Markov approximation (Max Bense's radio play *Der Monolog der Terry Jo*). In the age of Turing tests, there is a pesistent, uncanny (if not "traumatic") uncertainty whether the musical meaning arising in human derives from human or technological composition.

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[423] GWY 2015, referring to Ernst 2012: 286

[424] This has been expressed in George Dyson's lecture "No Time Is There: The Digital Universe", on occasion of the conference *Time and the Digital Universe* within the festival MaerzMusik, Berlin, Haus der Berliner Festspiele (March 12 / 13, 2016)

[425] See Karl Steinbuch, Automat und Mensch, 4th (revised) ed. Berlin / Heidelberg / New York (Springer) 1971, 130 f.

[426] Abraham A. Moles, Cybernetics and the Work of Art [FO 1965], in: Rosen (ed.) 2011, 217-225 (218)

[427] Gotthard Günther, *Das Bewußtsein der Maschinen*. Eine Metaphysik der Kybernetik, Krefeld / Baden-Baden (Agis) 2nd ed. 1963, supplement IV "Die 'zweite' Maschine" 179-203

[428] http://www.scholarpedia.org/article/Teleofunctionalism, accessed 5 April, 2018

Hermann von Helmholtz' differentiation between physiological acoustic perception ("Wahrnehmung") and musical sensation ("Empfindung") as well as the neuro-aesthetic focus of Systematic Musical Science on musical cognition, remains overtly anthropocentric. Technology-focused Sound Studies, on the contrary, listen to the sonic signal and from there define music as as cultural technique of "organized sound" (Edgar Varèse). With the media-epistemic concept of implicit sonicity as temporal, time-critical form, the notion of "music" does not only make sense for human receivers, but equally refers to the "algorythm" (Miyazaki) of programmed computation.[429] There is musical understanding (if not "meaning") within technological systems themselves; radical media archaeology here separates from phenomenology in favor of a techno-processual ontology.

[Against the „phenomenological anthropocentrism“ of discussing musical "meaning", Steve Goodman defines the "ontology of the vibrational force"[430]. There is implicit "hearing": "Sonic events – e.g. noises, sounds, music – are not perceived by the ear alone; with other bodily or material sensors, they trigger both physiological and physic reactions. In research of such phenomena, measuring devices, augmented by software intelligence, are the first listeners, first of all; only such technologies provide the means "to better understand and explore these and other affects."[431] The loss of "musical" control of sound by electronic variations is compensated by algorithmic control again. Media archaeological understanding leads to an "epochal" (Husserl), at least temporary disempowerment of the perceiver’s position as the listening subject; human "musical meaning" becomes open to non-hierarchical connections between sonic phenomena. There is the acoustic physical signal, which is perceived as "sonic" within humans by cultural prefiguration, and the musical sensation being semantically charged and temporally ordered. But once "rhythm is wrested from the established notion of measure in music, a perplexing diversity of terms, instruments and practices unfolds, situating it between a manner of flowing (ruthmos) and an order of movement, proportioned figure (metron) […]."[432] Rhythmic semantic can be derived from automatisms already, like the non-auditory planetary "spheric" music, diagramatically defined by Platon. Aesthetic experience does not come to existence in human perception only.]

In an advertising prospectus from 1905, the Freiburg Welte company differented between "mechanical music" from its personalized recording technique for reproduction piano "mit allen Feinheiten des rhythmischen und dynamischen Vortrags mit völligem Erfassen der persönlichen Note"[433]. Against the human pianist re-enacting "historic" scores, the reverse question arises: Does machinic "interpretation" preserve a different machinic meaning, arising

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[429] For such a blending of mathematical algorithm with musical rhythm, see Shintaro Myazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012 (http://computationalculture.net)

[430] Goodman 2010: 82

[431] The Berlin Club Transmediale (CTM) 2015 festival theme *Un Tune* draft; http://www.ctm-festival.de/festival-2015/theme

[432] Online draft for the *Rhythm-Expression* discussion of the Berlin festival MaerzMusik, hosted by Bojana Cvejić, Tom Engels and P.A.R.T.S. Research Studios group, with Bernhard Lang. Haus der Berliner Festspiele, 14 March, 2016, within the "Thinking Together" discourse program

[433] Gerhard Dangel (ed.), Aus Freiburg in die Welt. 100 Jahre Welte-Mignon: automatische Musikinstrumente, exhibition catalogue, Stadt Freiburg, Augustinermuseum, Freiburg i. Br. 2005, "Vorwort", 7-9 (8)

in the dynamics of the machine body? Welte-Mignon reproduction pianos "read" punched information from rolls, pneumatically triggering piano keys. Is the human musicologist or piano player, when reading or playing a score, him/herself in such a machine state, in the sense of the *turingmachine* with its tape-"reader"? Charles Babbage once derived the mechanics for programming his digital Analytical Engine (around 1830) from the Jacquard loom, from textile machines based on "digital", punched card notation. But different from a musical score, such "operative coding of a textile structure", when implemented mechanically, allowed for an instrument to algebraically generate not only repeated but new patterns[434] - implicitely "musical" algorithms in Ada Lovelaces sense .

Is the cultural phenomenology of "musical meaning" *incommensurable* with technical, that is: non-discursive embodiments of sound as articulation of specific tempor(e)alities? There is an asymmetrical relation between "sound" as signal event and "music" as cultural code - unless, in a technical recursion of the ancient European link between music and mathematics, "digital" media are understood as the truly techno-logical mathematization of sonic matter - and thereby a re-entry of the "musical" structure which is numerical ratios (harmony) and rhythms respectively "algorithmics"[435].

It has been in linguistic research that effective algorithms for recognition have first been developed - as transformation of physically measurable wave forms of speech signals into electric impulses; such operations are based first on electronic transduction and then the transformation of the time-signal to its frequency number.[436] Sonicity can not be reduced to the dynamics of waveforms, but encompasses mathematical operations and subsequently their machinic computing as well. Once a series of digits can represent waveforms, sound is liberated from its acoustic phenomenology. The statistic tools from corpus-based linguistics have been adopted for music analysis: "While the basic elements and features (or tokens) over which statistics are computed naturally differ between linguistics and musicology, the statistical concepts that allow us to infer regularities within the specific domain are quite similar or nearly identical. Among the chief statistical concepts that can be derived from frequency counts of tokens / features, and that are employed in both fields, are Markov models, entropy and mutual information, association measures, unsupervised clustering techniques, and supervised classifiers such as decision trees."[437]

The agenda of emancipating sound from music is media-epistemological indeed: It has been signal recording technologies and media theories (*avant la lettre*) which heightened awareness of the physicality of sound as vibrational event (both mechanical and electro-magnetic). In terms of ontological unrevealing, it is techno-logical analysis (such as spectrography and Fast

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[434] See Birgit Schneider, Programmierte Bilder. Notationssysteme der Weberei aus dem 17. und 18. Jahrhundert, in: Horst Bredekamp et al. (eds.), Das technische Bild, 2008, 182-190 (189)

[435] In Shintaro Miyazaki's sense; see xxx

[436] H. Schnelle, Automatische Sprachlauterkennung, in: Kybernetische Maschinen. Prinzip und Anwendugn der automatischen Nachrichtenverarbeitung, Frankfurt/M. (S. Fischer) 1964, 208-219 (211)

[437] Daniel Müllensiefen / Geraint Wiggins / David Lewis, High-level feature descriptors and corpus-based musicology: Techniques for modelling music cognition, in: Systematic and Comparative Musicology: Concepts, Methods, Findings, hg. v. Albrecht Schneider, Frankfurt am Main u. a. (Peter Lang) 2008, 133-153 (140)

Fourier Analysis) as well counts as a better "understanding" of sound than in human hearing itself.

For the media-archaeological understanding, the musical structure does not already unfold in a silent decoding of the score (as claimed by Theodor Adorno), but only as actual enactment, in its operative implementation in structurable matter - be it machine listening, or human cognition.

Is "musical meaning" dependent on sound as event in matter? In the symbolic order of score notation, "structural listening can take place in the mind through intelligent score-reading, without the physical presence of an external sound source"[438], as diagrammatical unfoldding of music. As conceived by Theodor W. Adorno, "the silent, imaginative reading of music could render actual playing as superfluous as speaking is made by reading of written material"[439].

Musical events (from noise to music) are not perceived by the human ear alone. Technological analysis not only provided the means with which to better understand bodily and neuronal affects; they have a musical understanding themselves.

When sound recording changed from technical signal recording (such as analog phonography) to calculation (in digital computing), this was not just another version of its materialities, but a conceptual change.

"Music" as cultural art form, in Western tradition, does not belong to the sonic realm, since it is primarily conceptual; from there stems its affinity to early programmed computer music such as Lejaren Hiller's Illiac Suite composition. In 1984, IBM Germany edited a combined book (Heinz Josef Herbort) and LP record called *Computer-Musik*, with the appropriate sub-title "Vertonung im Zeitalter der Prozeßrechner".

In the 1980s, Vilém Flusser lectured on the musical code as both concrete and abstract at the same time. Music, like mathematics, is an abstract code, triggering an intellectual process which Flusser termed “pure music"; even "visual codes become spontaneously 'musical'" once they no longer mean the outside world, "but inner, mental processes"; the media artist "transposes the processes of his brain onto [the] apparatus".[440] Flusser's enthusiastic correlation of music with mathematics looks at "pure music" as freed from discursive (aesthetic or cultural, even phenomenal or neurobiological) restrains. This situates human "musical meanng" in a non-historicist tempor(e)ality in itself - a truly structual, archaeological concept. Under this perspective, computer music is not simply a creation of the 20th century, but a recursion of the oldest concept of occidental music as such. All of the sudden, *logos* becomes musical again - in a deeper sense of *epistemé mousiké*. Logocentrism gets (algo)ryhtmicized. Flusser, in Lecture 16 at Sao Paolo, defines music as "any set of sounds purposely composed by the human intellect", while at the same time clearly separating between music as epistemic

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[438] Rose Rosengard Subotnik, Deconstructive Variations. Music and Reason in Western Society, Minneapolis (Univ. of Minnesota Press) 1996, chap. 3 ("Toward a Deconstruction of Structual Listenting. A Critique of Schoenberg, Adorno, and Stravinsky"), 148-176 (161)

[439] Subotnik 1996: 161 f.

[440] Flusser, Letter to the editor of *Leonardo* Magazine in review of an article, 1987 (information by Rodrigo Maltez Novaes, Research Fellow Vilém Flusser Archive, University of the Arts, Berlin)

structure and its physical implementation as audible sound.

Leibniz' modelled musical understanding within humans to be "a recondite arithmetical exercise" by the soul "which is unaware that it is counting". Such subliminal calculations actually happen in computations which are fast enough to complete a given task in real-time; time-bound model of musical reasoning. There is "musical meanng" even in the "transition time from straight to curved flight" of aeroplans, as calculated by the Bell Labs in 1943; its ca. 3 secs[441] correspinds with the human "time-window" of the present. Anti-aircraft artillery literally counts with such anticipatory timing and describes it in musical terms: "There is a silent music to it."[442]

In anti-aircraft prediction, the pre-calculated lists based on statistics become part of the actual present itself, its register, *online* as condition of data processing in real-time.[443]

When discovering sub-semantic poetic respectively musical articulation, interpretation results from measuring. Separating "music" from "noise", Norbert Wiener, with his method of *harmonic analysis* (borrowed from musical terminology) was interested in responses of a linear resonator to random impulses.

["This is physically realized by the well-known 'shot-effect' in vacuum tube circuits. In such a circuit, the current is carried across the vacuum by individual electrons, and, since these are indivisible, is subject to fluctations which are independent for non-overlapping intervals of time, and have a constant mean square average" = Norbert Wiener 1941 "On Linear Prediction", 1 (NA-227-D7-GP, Box 4, Folder: Project 6), quoted after: Roch 2009: 57. "Ein Signal, Bomber oder Elektron, lässt sich dann als Impuls von fluktuierenden Schwankungen trennen" = Roch 2009: 58]

"[M]usical time is the organization or the set of forms 'imprinted' <...> on sonorous matter, on sound."[444] Therefore sound is material, and music conceptual. If music is sounding matter shaped in symbolically ordered time, it is *drama*, while coded writing of music is symbolical time. "Real" time only takes places in analog signal recording or digital signal processing. Philip Glass, in 1974, remarked on Repetitive respectively Minimal Music: "So bleibt zu hoffen, daß man dann in der Lage sein wird, das „Jetzt“ der Musik wahrzunehmen, frei von jeder dramatischen Struktur, als ein reines Medium des Klangs"[445] - which subtracts the very term "music" itself.

Only when a musical score is decoded and *incorporated* into human performers or

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[441] NA-227-D7-GP. Box 12, Folder Project 11, "Diary of DJS Conference at NACA v. 9. März 1943, here quoted after: Roch 2009: 74

[442] Robert Silverberg, zitiert von Claude Shannon; hier zitiert nach: Roch 2009: 188

[443] Roch 2009: 162

[444] Jean-François Lyotard, God and the Puppet, in: ders., The Inhuman. Reflections on Time [*L'Inhuman: Causeries sur le temps, Paris 1988], Stanford, Cal. (Stanford University Press) 1991, 153-164 (153)

[445] Quoted after program brochure of the performance (Berliner Kammeroper) *In the Penal Colony*, music: Philip Glass, Hebbel-Theater Berlin, November 2002, 7

implemented into signal processing machines, it can be articulated as sound. "Music" is the semantic content of "organized sound"; the "sonic" message of a vibrational medium is the experience of time, just as in technological operations: "Media mediate change and are therefore the material form of time."[446]

Sound moves inbetween musical meaning in what it attempts to portray, and communication engineering[447] which measures and culculates the effects sound and frequencies have upon humans. "Musical meaning", at first glance, is excluded by communication engineering; Claude Shannon defines artificial languages abstractly, as "a stochastic process which generates a sequence of symbols"[448]. Warren Weaver, though, suggested to add the semantic dimension to Shannon's seminal diagram: "One can imagine, as an addition to the diagram, another box labeled 'Semantic Receiver' interposed between the engineering receiver (which changes signals to messages) and the destination. This semantic receiver subjects the message to a second decoding, the demand on this one being that it must match the statistical semantic characteristics of the message to the statistical semantic capacities of the totality of receivers, or of that subset of receivers which constitute the audience one wishes to affect."[449]

"Semantic" listening concentrates on *musical objects* like a melody. Whereby a melody is basically a contour kept and recognized in memory "over time" (in both senses), the time-critical approach of media archaeology rathers concentrates on non-harmonic micro-figurations of temporality within the sonic event. Effective algorithms are capable to identify "musical" qualities such as dynamic time warping[450], and to extract "the repetitive strucutre of an audio recording"[451].

"Objects of music cognition like melodies, rhythms, and harmonies [...] seem to be mentally represented in a form comparable with symbolic encoding formats."[452]

Computational "Deep Learning" conceptually aims at "musical cognition" previously limited to human brain capacities - a reentry of the archetypal cybernetic hypothesis that "musical" aesthetics in principle (*en arché*) is re-definable algorithmically, mechanizable as a turingmachine.

Cognitive processes like memory encoding, retrieval and similarity perception are obviously

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[446] Sean Cubitt, The Practice of Light, Cambridge, MA (The MIT Press) 2014, 257, as quoted in the introduction to Timothy Barker, Television In and Out of Time, forthcoming in: Andrew Hoskins (ed.), Digital Memory Studies. Remembering through digital and social media, London / New York (Routledge)

[447] Barry Truax, Acoustic Communication, Norwood, N. J. (Ablex) 1984

[448] Claude Shannon, Collected Papers, Piscataway (IEEE Press) 1993, 5

[449] Weaver, in: Shannon / Weaver 1963: 26

[450] See Müller 2007: 69

[451] Meinard Müller, Information Retrieval for Music and Motion, Berlin / Heidelberg / New York (Springer) 2007, 165

[452] Müllensiefen et al., 133

influenced by the familiarity of the musical material that is to be processed.[453]

Techno-logical understanding differs from of sense-making in human hearing. Claude Shannon, in his notorious diagram of communication engineering, makes a difference between the technical reception and the final "understanding" of a received message. The ear becomes an electronic receiver. Zwicker called the ear a "Nachrichtenempfänger", with the brain being the final destination. Does media-archaeological analysis arrive at its limits when it comes to explaining "musical meaning"? A bridge, though, are the measuring instruments and modeling algorithms (software) for brain research. To what degree is the identification of "musical meaning" itself an effect of such an apparatus?

The research group Music, Mind, Motion, Machines[454] works on music cognition, by application of sensor technologies, motion tracking cameras, and machine learning which is an actualization of the cybernetic premise. Motiongrams and sonograms made from recordings of oral poetry or muscial performances allow to identify the correlation of musical meaning and gesture, just like articulated speech in its rhythmic pattern when expressed on a typewriter. Juste as Nicolai Bernstein analyzed piano play by chrono-cyclograms in post-revolutionare Russia[455], motion caputure of musical gestures nowadays inculdes video-based computer vision techniques, infrared, electromagnetic, ultrasound, mechanical and inertial motion capture systems.

[Braguinski's analysis of the asymmetries between singing and string instrument motion in the case of the Berceby song; video URL]

Successful *synthetic* production of semantically "meaningful" music sensation within humans are the proof that "musical meaning" can be reduced to second-order syntax by techno-mathematical *analysis*.

LISTENING TO SONIC EXPRESSIONS WITH MEDIA-ARCHAEOLOGICAL EARS

Media-archaeological argumentation turns the notion of sound upside down in order to reveal, below its apparent auditory phenomena, its epistemological essence which is an enunciation of specific *tempor(e)alities*. The notion of "implicit sonicity" reveals the hidden chrono-epistemological implications of sound itself. While sound as acoustic vibration is a physically material event, in its temporal form ("implicit sonicity") which affects the human sense of time it is volatile and immaterial. How does sound as matter relate to its immaterial timing?

In a fundamental sense, sound *matters* as time-critical articulation. The concept of "sonicity" as epistemological approach is rather related to media-archaeology than to the acoustic. Sonicity happens as non-material oscillations even without being heard as acoustic "sound" any more. "When we see rhythm preserved in a radio aerial, we cannot stop the image of a reciprocal action between the geometric and the temporal from intruding into our thought. It is

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[453] Muellensiefen et al., 136

[454] See Rolf Inge Godøy / Marc Leman (eds.), Musical Gestures
Sound, Movement, and Meaning, New York / London 2010 (Routledge);
http://www.uio.no/english/research/groups/fourms

[455] See Julia Kursell, "Moscow eye"

therefore on our best interests to regard things as truly the products of stationary waves. Periods are spatio-tempoiral function. They are the temporal face of material things. As it vibrates, a thing reveals both a temporal and a material structure."[456]

The almost immaterial sonicity of electro-magnetic waves, far beyond simply a phenomenon in acoustic culture, make "sound matters" a fundamental event of being-in-the-world. There is sound in the machines themselves, in symbolic representation (data) and and non-symbolic occurance (signals).

According to Norbert Wiener's seminal cybernetic definition, information - measured in *bits* - is "neither energy nor matter". Is the current interest in sound therefore a "post-digital" nostalgia for vibrational matter? Sonic auscultation is an attempt to capture the volatility of sound and reveal its temporal message in a concrete manner through the algorithmic stethoscope, which is software for sound analysis.

Spectral analysis of sound transforms the signal from the time domain into the frequency domain. The analytic science has become aesthetic practice in "spectralism" as compositional technique in contemporary music[457], where the experimentation of micro-times is being replaced by mathematical patterns.

Sound ~~art~~ matters: Implicit "sonicity"

In discussing the essence of the *tone*, G. W. F. Hegel defines it in its temporal essence: "Ein Verschwinden des Daseins, indem es ist"[458]. - a disappearance of being, while it exits.

The commonality of sound, vibration, light, and technical image lies in their equal condition that by analytic measuring media they can be identified as time-critical frequencies. The existence of sound *in* and *as* time signal is twofold: its explicit tempor(e)alities in human perception and its implicit dynamics as epistemic object.

The privileged alliance between technological events and musical sound is based on their common denominator which is its temporal processuality. This is evident in a central electro-technical device: the resonant circuit, otherwise significantly called "tuned" circuit. Such an electric circuit consists of an inductor and a capacitor in mutual connection. "The circuit can act as an electrical resonator, an electrical analogue of a tuning fork, storing energy oscillating at the circuit's resonant frequency."[459] Resonant circuits are used either as sender (for generating signals), or as receiver (for picking out a signal at a particular frequency from a band of carrier signals), particularly in radio technology, up to the mobile media in digital wireless communication.

In an experiment from 1889, David Lodge placed two resonant circuits next to each other, each

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[456] Gaston Bachelard, The Dialectis of Duration [FO 1950], Manchester (Clinamen) 2000, 78

[457] See Hugues Dufourt, Musique spectrale: pour une pratique des formes de l'énergie, in: Bicéphale no.3 (1981), 85–89

[458]G. W. F. Hegel, Enzyklopädie (1830), § 459 (= Werke, Frankfurt/M. 1970, vol. 10, 271)

[459] http://en.wikipedia.org/wiki/LC_circuit (accessed 23rd January, 2015

consisting of a Leyden jar connected to an adjustable one-turn coil with a spark gap. When a high voltage from an induction coil was applied to one tuned circuit, creating oscillating currents, electric sparks were excited in the other tuned circuit only when the circuits were adjusted to resonance. Not by coincidence engineers borrowed the terms to describe the micro-temporal event of oscillatory electro-magnetic discharge from musical science. "Lodge and some English scientists preferred the term 'syntony' for this effect, but the term "resonance" eventually stuck."[460]

What McLuhan once daringly termed "acoustic space", is more fundamental than what the human ear can hear, indeed. As the radio producer Tony Schwartz wrote in his book *The responsive chord* in 1974: "In discussing electronically based communication processes, it is very helpful to use auditory terms [...] like *feedback* ... *reverberation* ... *tuning* [...]."[461]

"Sonicity" inbetween vibrational force and electro-magnetic waves

In *The Audible Past* , Jonathan Sterne differentiates sound as perceptual quality from mechanical vibration as physical event: „As a part of a larger physical phenomenon of vibration, sound is a product of the human senses and not a thing in the world apart from humans. Sound is a little piece of the vibrating world“[462] and „somewhat human-centered“[463]. But some conditions must be given "for something to become recognized, labeled and valorized as audible in the first place"[464].

Vibration encompasses both a „dissolution of matter“ as well as „sensory experiences of things which vibrate“[465]. Vibration (such as in high frequency radio) operates even before being translated into sense-data called sound, light, heat - against „purely audiological conceptions of sound“[466] which limit the frequency range. Against a „naive physicalism“ and a „phenomenological anthropocentrism“, Steve Goodman defines the "ontology of the vibrational force" as an "in-between of oscillation, the vibration of vibration, the virtuality of the tremble. Vibrations always exceed the actual entities that emit them. Vibrating entities are always entities out of phase with themselves."[467]

The theoretical conceptualization of vibration carries itself a temporal index: In late 18th and 19th century, "new technologies and scientific theories heightened awareness of the physicality of sound as vibration"[468], while at the same time generating non-mechanical

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[460] Wikipedia ibid.

[461] Garden City, New York (Anchor books), 23

[462] Sterne 2003: 11

[463] Sterne 2012: 7

[464] Veit Erlmann 2010: 18

[465] Shelley Trower 2012: 7

[466] Friedner/Helmreich 2012: 76, as quoted by Papenburg

[467] Goodman 2010: 82

[468] Trower 2012: 2

vibrations like the electro-magnetic oscillation, technologies of telephony and radio.[469] Tactility is the mode in which sound can be experienced by humans as vibration - different from the electro-magnetic field ("light") which does not mechanically enact pressure.

The English noun "sound", in German, splits into two different notions: a) *Schall* which is the physical acoustic air pressure which can be perceived by the human ear and hearing; b) *Klang* which names the periodic, harmonic sonic events.

Taken at face value, sound is "mechanical disturbance from a state of equilibrium that propagates through an elastic material medium"[470]. But German language differentiates between *Schall*, *Klang*, *Ton*. In English, the semantics of "sound" embraces all this trinity.

Sound excludes noise by definition - but noise is integral to communication theory. Sound therefore is too limited in its epistemological scope. The notion of "sonicity" includes noise as the stochastic alternative to music in Iannis Xenakis' sense and in terms of electronic music: subtractive sound synthesis creates "order from noise", filtering frequency bands, an all-encompassing "drone" ambience which is continually present throughout and from which sound can be extracted - different from the traditional Occidental additive notion of sound from single harmonic proportions or sine waves. Additive music builds sonic events up synthetically, with its base being silence, whereas the substractive musical concept actually begins from sound. Here, all the notes and possible notes to be played are present before the musicians even start playing.[471]

Sonicity refers to the specific temporal knowledge which is implicit within sonic instruments of analysis and synthesis[472] on the one hand, and to graphically or mathematically derived sound on the other.[473] This even extends to the concept of non-struck sound like the theoretical fiction of vibrational forces called "ether".[474]

At that point, the semantic associations of "sonicity" might start to get misleading. In 19th century discussions on the nature of electro-magnetic phenomena, acoustic terms have been

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[469] Trower 2008: 134

[470] Encyclopaedia Britannica, 2003

[471] See Bill Viola, The Sound of One-Line Scanning, in: xxx 1990, 44

[472] In that sense, John Durham Peters writes of "sonic revelations" of the vibrational qualities of the human eardrum by Hermann von Helmholtz' artefactual resonators (Resonatoren): Helmholtz, Edison, and Sound History, in: Lauren Rabinovitz / Abraham Geil (eds.), Memory Bytes. History, Technology, and Digital Culture, Durham / London (Duke University Press) 2004, 177-298 (185)

[473] Derivation is meant here in its sense of mathematical differentiation as well where the derivative of a sinusoidal function describes its rate of change near a chosen input value. On the close ties between mathematical abstraction and phonocentricity in early Indian science see Moebus / Wilke 2011, 227

[474] The term "sonality" has been proposed to name such concepts: see Oliver Moebus / Annette Wilke, Sound and Communication. An aesthetic cultural history of Sanskrit Hinduism, Berlin / New York (de Gruyter) 2011, 12 and 705

borrowed, e. g. Maxwell's notion of the "electrotonic state"[475]. It had been Christiaan Huyghens' "undulation theory" which equalled light to acoustic waves, resulting in the literally "media"-theoretical fiction of an ether.[476] But the equation of electro-magnetic "waves" with elastic mechanical vibrations is just a heuristic model to gain metaphorical evidence (*Anschaulichkeit*) of an otherwise directly impercetible event.[477] Maxwell cautions on the (otherwise useful) analogy between light and the vibrations of an elastic medium.[478]

From bodily sound ... to the all-embracing sonic?

"Sound matters. It mediates between the real and the virtual, connects the physical reality of acoustics with the mental reality of the muses."[479] But even if the affective potential of sound is clearly a focal point, "yet it constitutes only one aspect of an investigation into the distribution, modulation, and perception of frequencies"[480]. Therefore sonicity might be liberated from sound. With the traditional distinctions between noise, sound, and music being increasingly blurred in artistic practice, "the concept of 'the sonic' <...> as an overall category <...> transgresses the limits of the musical and the acoustic" (ibid.) and opens into "the spectrum between bio-acoustical field recordings, brainwave entrainment, binaural beats, biofeedback, psychoacoustics, noise, and sub-bass vibrations"[481]. Such vibrations are delicately moved matter.

Material sound *versus* electro-magnetic sonicity

Even if sound is - to human perception - the most immaterial matter, still it is different from the electro-magnetic waves which touch the human eye as really immaterial "light". Sergei Eisenstein was wrong when the asked "to remove the barriers between sight and sound"[482]. In terms of harmonic relationships there might be a symmetry between the visual and the

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[475]"Elektrotonischer Zustand", in: James Clerk Maxwell, Ueber physikalische Kraftlinien [= Ostwalds Klassiker vol. 69], 5

[476] Criticized by Albert einstein, Äther und Relativitätstheorie, Berlin (Julius Springer) 1920, esp. 9f

[477] Josef Maria Eder, Photochemie (die chemischen Wirkungen des Lichts), Hallen (Wilhelm Knapp) 1906, 11

[478] "[...] so müssen wir doch dessen eingedenkt bleiben, dass sie nur auf einer formalen Aehnlichkeit zwischen den Gesetzen der Lichterscheinungen und denen der elastischen Schwingungen beruht": James Clerk Maxwell, Ueber Faraday's Kraftlinien, ed. L. Boltzmann, Leipzig (Akadem. Verl.-Ges.) 1898, 5 [Reprint 1995]

[479] Martin Carlé / Anastasia Georgaki, Re-configuring Ancient Greek Music Theory through Technology. An adaptive electronic tuning system on a reconstructed ancient Greek barbiton, in: Michèle Castellengo / Hugues Genevois (ed.), La musique et ses instruments / Music and its instruments, Sampzon (Éditions Delatour France) 2013, 333-380 (335)

[480] CTM 2015 theme

[481] CTM 2015 theme

auditive, but in terms of (electro-)physics there is an epistemological asymmetry between mechanical, violent vibrations and electro-magnetic "waves". Optophonic "listening" to the "sound" of visual patterns by sonification rather obscures this fundamental difference.

(Ultra-)Sonic imaging

The electronic image, different from traditional painting, with its 650 successive lines every 25th / second, only exists when succeeding within a time-critical window of synchronized presence. Video artist Bill Viola actually listens to "The Sound of One Line Scanning"[483]. Marshall McLuhan actually termed electronically mediated communication "acoustic space".[484]

Ultrasound imaging, known from medical diagnosis, itself is images based on sound, where the (comparative to EM waves) slowness of acoustic waves (echo delay) are used to create electronic signals which can computatinally be transformed into two-dimensional visual data. Such sound phenomenally is not experinced directly (binaurally) but indirectly seen, as image.

Ultrasound, by definition, transcends (above 20 kHz) the realm of acoustic signals which can at least be recognized within the audible range of the human ear.

Different from visualised "light sound" from celluloid in cinema, in sonography the inaudible sound is visually revealed. The age of sound film is linked to the functional (Fournier d'Albe) or aesthetic (Raoul Hausmann) "optophone".

Sound & matter *versus* the electronic audio signal

All kind of "waves" are a form of energy transfer without physical transport. Still there is a radical difference between mechanical and electro-magnetic waves. Acoustic vibrations are among the most immaterial articulations of materiality. Not only can physical matter can be forced to vibrate, but - as pointed out by Henri Bergson - matter itself consists of vibrations, that is: implicit sound.[485] Matter thus resolves "into numberless vibrations, all linked together in uninterrupted continuity, all bound up with each other, and travelling in every direction like shivers through an immense body"[486].

But "sound" relates to "matter" only in the acoustic sense of mechanical vibrations. The oscillations of the electro-magnetic field are a different kind of sound. Let us therefore undo the tight sound/matter coupling, in favor of a more processual, time-critical notion of sound as signal event.

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[482] Sergei Eisenstein, the Film Sense, New York 1969, 87

[483] In: xxx Lexier (ed.), Sound by Artists, xxx

[484] See Tony Schwartz, The Responsive Chord, New York 1974

[485] As emphasized in the Mauricio Lazzarato, Video Philosophie, Berlin (b-books) 2xxx

[486] Henri Bergson, Matter and Memory, London (George Allen & Unwin) 1950, 276

When propagated in a physical medium like air or water, sound is the most ephemeral form of matter; itself it has no solid materiality but is matter unfolding in time. Matter here becomes a tempor*e*ality, like an analog electronic image which the video artist Bill Viola once described as "The Sound of one-line Scanning". "Phonovision" was the name given to gramophone records as storage medium of the earliest electro-mechanical Baird-Television picture series.

When mechanically propagated sound is being technically transduced, this is not simply a linear translation, but it changes its essence from acoustic to electric signal. Within a telephone line, or when stored as magnetic charges on tape, a media-epistemological "transsubstantiation"[487] of sound has happened, since as such the audio event becomes accessible to signal processing.

The so-called audio signal, beyond its possible origin in the physical world, may came into existence by electronic generation exclusively - in electro-technical *autopoiesis*.

The real essence of sound such as in Electronic Dance Music or Drum and Base is not primarily bodies but electrons in periodic motion. As (still) human composition or mix or mastering, it is still *musical* , while the *sound* itself has been de-corporalized completely, neither be connected to a human performer or voice nor to a mechanical instrument any longer. What started with the electronic live recording and studio editing, now has become the message of the electronic and algorithmic (that is, techno-logical) medium itself.

Beyond the physical world of mechanical vibrations, the sonic articulation, on the electronic level, exists as signal only. In reverse, electrons - the essential elements of electronic media - are themselves accompanied by waves. Erwin Schrödinger intuitively recalled the oscillating monochord and thereby defined implicit sonicity: "Suppose the electron in the hydrogen atom is analogous to a string - tied at both ends - in a musical instrument. Such a string emits a very definite tone together with its overtones, but not the wavelenghts in between. With this idea in mind, Schrödinger <...> set up a wave equation for the electron"[488] - which is the only true "radio", as radiation.

The electro-acoustic "lab": Cologne *versus* Paris

Memory manipulation on and by tape has been common practice in the heroic age of magnetophone-based audio engineering. This actually reminds of the different techno-aesthetics of the Paris electronic music studio run by Pierre Schaeffer with its conceptual *musique concrète*. Stockhausen criticized the Paris studio for its aleatory concept of "found sound" (passive magnetophone recording and then active manipulation) rather than generating electronic sound genuinely from non-environmental electronics.[489]

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[487] In the Catholic liturgy, the substance, or reality, of the Eucharistic offering (either bread alone, or bread and wine) is changed into both the Body and Blood of Christ. See the entry "Transsubstatiation" in the *online* encyclopedia Wikipedia: https://en.wikipedia.org/w/index.php?title=Transubstantiation&oldid=696228320; page status: 21 December 2015

[488] Steve J. Heims, John von Neumann and Norbert Wiener. From Mathematics to the Technologies of Life and Death, Cambridge, Mass. / London (MIT) 1980, 103

[489] See Baumgärtel 2015: 100

Only in electronics, the almost pure sine wave as elementary unit exists (which fascinated young Stockhausen).[490] In its physically impossible form, the *ideal* sine wave has a technological existence indeed: within the digital computer as mathematical function expressed in executable code.

A primary difference between the Paris studio of *musique concrète* (Pierre Schaeffer) and the Cologne WDR radio of Electronic Music (created by Herbert von Einem) is not simply an aesthetic but a media-epistemological one: Recording and manipulation of originally physical sound *versus* electronic sound generated by tone oscillators from the beginning, in pure sonicity. There is electro-mechanical kinetics and tactility on the one side, and circuitry-operative electronics on the other.

In artistic practice the active co-agency of the magnetophone has been recognized by pianist Glenn Gould.[491] Many of such compositions enhance the live performance by human musicians in communication with pre-recorded sound. It has been against this tape-based sampling that, in contrast, the computational paradigm of real-time human-machine-interface developed, such as Roland Pfrengle's piece *Klaviermusik* (1984).

Very experimentally, Karlheinz Stockhausen in the Cologne Westdeutscher Rundfunk radio station "Studio für elektronische Musik" generated sine waves genuinely from within electronic oscillators. Notably his piece *Kontakte* (created contemporary to KLT, 1958-1960), in its first version, is not primarily about communicational "contacts" between human instrumentalists and sound machines any more but about the coupling inbetween electronics in its radically *non*-discursive *autopoiesis*. While for instrumental parts there is a conventional score, the electronic parts are in graphic representation.

De-materialization? Digitalized "sound"

When acoustic sound becomes transduced into an electric signal, it can thereby modulate a radio high frequency carrier band. Electro-magnetic waves do no mechanically touch the human ear. All the sound is there but unhearable - the implicit sonicity of electromagnetic vibrations, close to what humans perceive as light (especially in Ultra Short Wave radio transmission). The electro-magnetic event is not material any more but an epistemological challenge to re-think sound-as-matter. It can only be phenomenologically observed by its effects or needs mathematically to be diagrammaticized (Maxwell's equations).

Once the analog audio signal becomes digitized, the term "signal processing" becomes fully justified in terms of computing. Coded in binary values, the signal within computing devices shall not be called "audio" any more, even if it can - by digital-to-analog conversion - be emitted via loud-speaker for human ears as sound again. What phenomenologically appears like sound has inbetween (in the techno-logical media channel) gone through a complete substantiation. In digital media, we have lost "sound".

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[490] See Tilman Baumgärtel, Schleifen. Geschichte und Ästhetik des Loops, Berlin (Kulturverlag Kadmos) 2015

[491]See the "Glossary" explaining practices of audio tape recording and cutting, in: Glenn Gould, Vom Konzertsaal zum Tonstudio, Munich / Mainz 1992, 173

The gap between the material recording of a sonic event and informational ephemerality principally started with the first coded inscription already: the alphabet. The binary code is the smallest possible of such alphabets, and its advantage stems from its distinctive signal-to-noise ratio in signal transmission and signal storage, such as Pierce and Shannon definied a "Philosophy of PCM"[492].

Friedrich Kittler, in his writings on the entanglement of music & mathematics, reminds that one and the same alphabet has been used to notate verbal language, music and mathematics - a "unicode" which unexpecedly returned as alphanumeric notation with the digital computer. This recursion can not be described in terms of cultural history any more but calls for a different diagram of cultural timing.

Digitized signals at first sight resemble the tradition of music notation (the score), but in addition, they are endowed with operational activity: they are algorithmically executable. Symbolic archival permanence is almost time-invariant, sublated from change with time, leading to ahistorical immediacy in the moment of re-play. We are not tuning into the past any more in sonic temporality.

BETWEEN PHYSICS AND INFORMATION: AUDIO RECORDINGS FROM THE PAST AND THEIR TEMPOR(E)ALITIES

Technical recording vs. symbolic transcription

Since the invention of the phon(aut)ograph, the analogue audio-recording media have built up a signal-based memory of sound alternative to the symbol-based archive of musical notation. A collection of wax cylinders or gramophone records is rather a "counter-archive"[493] of sonic memory in the sense of Henri Bergson's and Edmund Husserl's emphasis on the human form of temporal experience as affective rather than clock-like integration. Signal-based records constitute a different kind of memory than the alphabetical scores which constitute the traditional "audio" archive.

Long time ago, an early Greek adaptor added single symbols for vowels to the known Phoenician alphabet for the purpose of making not only the rough content but the very musicality of oral poetry explicitely recordable. But even this advanced notation inspired by the Muses is still symbolic, like the score transcriptions which Béla Bartók provided for Milman Parry's recordings of songs by Yugoslav singers of tales on aluminium disc. What these discs were able to record, though, was not only oral poetry itself but the non-musical articulations as well, a surplus. Bartok himself comments:

There are many "conversations" in addition to the songs incorporated in the recording, talks between collector and singer concerning data connected with the song, with the singer, with the circumstances referring to the performance of the song, etc. When you listen to these

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[492] In: xxx

[493] See Paula Amad, Counter-Archive. Film, the Everyday, and Albert Kahn's Archives des la Planète, New York / Chichester (Columbia University Press) 2010, 153. The phonographic equivalent of Kahn's cinematographic project have been the Archives de la Parole, foundet by the linguist Ferdinand Brunot in 1911 at Sorbonne University, Paris

"conversations" you really have the feeling of being on the spot <...>.[494]

This acoustic supplement extends even to non-intentional, non-semantic evidence, such as noise or bird-singing in the background or the singer's coffing during performance - information which might be important for a realistic interpretation of the circumstantial conditions of oral poetry. Acoustic media both keep and reveal a *mémoire involontaire* of past acoustics which was never intended for tradition - a noisy memory, unaccessable for symbolic notation in the traditional sense.[495]

Different from transcriptions into scores, technical signal-recording of musical articulation allows for the electro-physical measuring of recorded events by "sampling". This enables a non-hermeneutic analysis of cultural articulation on the sub-philological, sub-alphabetic level.

Entropical and negentropical sound memory

Analogue recording media consist of two bodies. There are two complementary approaches to the conservation of analogue audio carriers. The one cares for preserving the physical, especially chemical and electro-magnetic properties of the concrete media body - since all media technologies are hardware in the first place. The other, sometimes opposing approach is to preserve media-based memory as information, up to the extreme point of view that the material body might be abolished after its essential transcription into its pure binary information units. "We no longer collect the carriers, clay tablets, books or floppies, just the information."[496] But to which degree does the archival authority of an audio record still depend in its material physical embodiment? Is it no longer important by which carrier one generation passes on its information to the next?

Soon after the emergence of photography as the oldest analogue signal-based medium in the technical sense, in 1859 Oliver Wendell Holmes pointed out the symbolic trade between information and materiality: "From now on, form is separated from material. In fact, the material in visible objects is no longer of great use, except when being used as a model from which the form is constituted. Give us a couple of negatives of an object worth seeing ... that's all we need. Then tear the object down or set it on fire if you will ... the result of this development will be <...> a massive collection of forms that <...> will have to be <...> placed in great libraries."[497]

Indeed, once the mechanically engraved sonic signals on material carrier (phonograph) or magnetically embedded (magnetophon) has been transformed into binary code, it can be (virtually lossless) "migrated" from one computing system to another.

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[494] Béla Bartók, Parry Collection of Yugoslav Folk Music. Eminent Composer, Who Is Working on It, Discusses Its Significance, in: The New York Times, June 28, 1942

[495] On notational systems see Nelson Goodman, Languages of Art. An Approach to a Theory of Symbols, Indianapolis (Hackett) 2nd ed. 1976

[496] Tjebbe van Tijen, We no longer collect the Carrier but the Information, interviewed by Geert Lovink, in: MediaMatic 8 No 1/1994; translation: Jim Boekbinder

[497] Quoted from: Wolfgang Kemp, Theorie der Fotografie I (1839–1912), Munich 1980, p. 121

Archival endurance in preserving the sonic heritage thus is not achieved in the traditional way any more (which used to be monumental fixation), but requires repetitive dynamic refreshing. In the early days of digital computing technological storage devices like the mercury delay line and the Williams Tube resembled the human memory mechanism in its predominantly "regenerative" character "between the passing and the repetitive"[498]. From this derives a fundamental change in the philosophy of how to secure media-archival data for future use: "If our machines' memories are more permanent, it is because they are constantly refreshed so that their ephemerality endures" <Chun 2007>.

In fact this repetition of the identical differs from the variable mechanism of oral tradition already, such as Homer's epics across the "dark" centuries without writing.[499] But such pre-technological variation (rather "cultural technique") itself became evident only by signal recording. Bartok comments on occasion of his transcriptions of phonographic recordings: "Folk-songs are a living material; and <..> subject to perpetual changes, preserving constancy only of certain general formulae. <...> the same poem has been recorded from different singers, in order to show what are the <...> traits depending on the individual singers, and what are the permanent ones, beyond the personality of the singer."[500]

Material media are marked by their individual degree entropy and characteristic probabilities of physical endurance. The *Eigenzeit* of physical media differs from the software-based media by embodying fundamentally different temporal regimes. Bartók optimistically commented the media memory conditions of the phonographic recordings of oral poetry made by Parry: "The records are mechanically fairly good <...>. Aluminum disks were used; this material is very durable so that one may play back the records heaven knows how often, without the slightest deterioration. Sometimes the tracks are too shallow, but copies can be made in almost limitless numbers."[501]

But physical recording media are subject to macro-temporal entropy - known as the chemical deteriorisation of Edison cylinders and magnetic tapes. Digitized signals at first sight resemble the tradition of music notation, but are endowed with operational activity; they are algorithmically executable. Symbolic techno-archival permanence is almost time-invariant, sublated from change, leading to ahistorical immediacy in the moment of re-play.

Phonography *versus* magnetophon: Electronics makes a difference

In May 2011 two Black Boxes could finally be rescued from the ground of the Atlantic sea two years after the Air France aeroplane crash: the data recorder and the voice recorder keeping

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[498] Abstract of the paper given by Wendy Hui Kyong Chun, The Enduring Ephemeral, or the Future is a Memory, to panel 6: Media Theory in Cultural Practice, *re:place 2007. The Second International Conference on the Histories of Media, Art, Science and Technology,* November 15th to 18th, Berlin (Haus der Kulturen der Welt) 2007

[499] See Astrid Erll, Odysseus' Reisen. Remediation und transkulturelle Erinnerung, in: Sonja Klein / Vivian Liska / Karl Solibakke / Bernd Witte (eds), Gedächtnisstrategien und Medien im interkulturellen Dialog, Würzburg (Königshausen & Neumann) 2011, 125-143

[500] Bartok op. cit.

[501] "Parry Collection of Yugoslav Folk Music. Eminent Composer, Who Is Working on It, Discusses Its Significance", by Béla Bartók, in: *The New York Times*, Sunday, June 28, 1942; Dokument aus dem Internet: Milman Parry Collection © 2006 = GUSLARIBARTOK>

the last words of the pilots in the cockpit but as well the background noises which retrospectively signal the unfolding desaster. The recordings proved to be miraculously intact. Both data recorders consist of memory chips which keep their magnetic charge, different from mechanically vulnerable previous recording media. Whereas mechanical records still represent the culturally familiar form of physical impression (writing), electro-magnetic latency is a different, sublime, uncanny form of insivible, non-haptic memory. The voices and sounds emanating from such a black box are radically bodiless, generating a different temporality than the familiar historio-graphical time.

Sound recording does not simply unfold as evolutionary course of technology in history, but the phonographic record on the on hand, the magnetic record on tape on the other, and finally the digital recording represent fundamentally different materialities and logics (literally techo/logy) in terms of their ways of registering time-variant signals, time-based forms of reproduction and their "archival" being in time. The electronic tube, especially the triode, once liberated technical media from mechanical constrains, thus: from erasure over time; still the tube or transistor are subject to decay over time themselves.[502] Negentropic persistence against entropic time[503] ows its ahistoricity rather to its different form of registering the physically real acoustic event not by signals, but by binary symbols.

The difference between mechanical and electro-magnetic audio recording is not just a technical, but as well an epistemological one. While the phonograph belongs to what Jules-Étienne Marey once called the "graphical method" (analog registering of signals by curves), the magnetophone is based upon the electro-magnetic field which represents a completely different type of recording, in fact a true "medium". What used to be transitive, invasive writing into a storage medium like the wax cylinder has been substituted by the electro-magnetic field, but writing nowadays re-turns as digital encoding in different qualities. Sampling and quantizing of acoustic signals transforms the time signal into frequencies as analysis and as a condition for re-synthesis (Fourier analysis and synthesis). The Technical Committee of the IASA in its standard recommendations from December 2005 points out that digitization of analogue sound carriers from the past does not necessarily mean a loss of information about the signal, but can in fact grasp the physical signal as information much more precisely than former analog recording where non-linear distortions of the signal in the process of technological transcription frequently take place. The Nyquist / Shannon theoreme already fixes that with a sufficient sampling rate the original signal can be truly reconstructed; for archival needs a radical over-sampling up to 192 kHz does not just keep the blunt sound information, but the memory of noise (scratches) as well.[504] Nevertheless, digitalization means a radical transformation in the ontology of the sound record - from the physical signal to a matrix (chart, list) of its numerical values. Media culture thus turns from phonocentrism to mathematics.

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[502] "Magnetophon und tönendes Buch [sc. Schallfilm] zeigen - im Gegensatz zur akustisch-mechanischen Schallaufzeichnung - keine mechanische Beanspruchung und Abnutzung des Werkstoffes. <...> Ein nicht unwesentlicher Gesichtspunkt ist schließlich die archivalische Eignung, die Zeitbeständigkeit der Phonogramme. <..> Am Schlechtesten schneiden abermals die Edison-Phonographen ab: weder Walzen noch Matrizen sind so dauernd und zeitbeständig, wie man es von einem archivalischen Quellenstoff erwarten muß." <Ibid.>

[503] Entropy in the second law of thermodynamics (Ludwig Boltzmann) states that the energy circulation of any closed system tends to an uniform equilibrium. In technomathematical communication theory (Claude Shannon), the term has been reversed to measure the degree of information.

[504] See http://www.iasa-web.org/IASA TC03/ IASATC03.pdf

A counter-archive? Acoustic archaeology

There is a distinctive difference between so-called "social" respectively "collective memory" of musical events and the actual media recording of sonic articulation from the past. For an archaeology of the acoustic in cultural memory the human auditory sense does not suffice. Let us, therefore, track the sonic trace with the genuine tools of technical media. One such way of "acoustic archaeology" is to play a musical partition on historic instruments. But the real archaeologists in audio archaeology are the media themselves: measuring devices which are able to de-cipher physically real signals and to represent them in forms alternative to alphabetic writing, resulting in sinusoidal articulations in time, operative diagrams such as being indicated by the oscilloscope.

Media-active archaeology can be applied to past sound, generating a different kind of audio-archive. When listening to "ancient" recordings from Edison wax cylinders, nowadays being restored with technomathematical software as digital re-production of sound, we might ask with Michel Foucault (in a slightly different context[505]): message or noise?

Today, opto-digital reading of early Edison cylinders allows for listenting again to otherwise unaccessible sound recording; the opto-digital *close reading* of sound as image, though, dissolves any meaningful unit into discrete blocks, which are accessible for human analysis only by operative techno-mathematical diagrams. This is a truly analytic, media-archaeological form of deciphering the sound of the past. It requires a media-archaeologically tuned ear to make knowledgable use of that option as an alternative to the cultural emphasis on musical semantics. To the media-archaeologically sharpened mind, sonic articulation visible on a computer screen will never be confused with a "live" sound since such a mind is conscious of the algorithms of which such an animation is a technomathematical, processual function.

At that point, the archival operation extends from restauration and conservation to re-animation and thus becomes a true media-archaeological operation. In a novel called *Time Shards*, the science fiction author Gregory Benford imagines a research laboratory which reconstructs "fossil voices" out of the grooves of mediaeval pottery.

In media-active archaeology, the technological apparatus itself turns out to be the archaologist proper. Patrick Feaster and David Giovannoni succeeded in re-sonifying phonautographic diagrams preserved from pre-Edision times, beginning with Léon-Scott's recording of a sound folk tone of 435 Hz in the year 1859. This self-referential (and auto-poietic) memory of sound technology itself is as worth to be preserved for eternity as any other more articulate cultural sound (the ethno-musical sources). With a dela of 150 years science fianlly realized that with optical "reading" of such acoustic signal lines sound can be algorithmically re-synthesized, and all of the sudden the children's song "Au clair de la lune, Pierrot répondit" (recorded by Lèon-Scott on April 8, 1860 in Paris) resounds again.[506]

What has been metaphorically described as the pick-up of sound images by a "virtual, digital gramophone needle"[507], in fact is something media-epistemologically different, a picking-up of

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[505] Michel Foucault, Message ou bruit? [*1966], in: same author., Dits et Écrits I, Paris 1994, 557-560

[506] Hear http://www.firstsounds.org/sounds/1860-Scott-Au-Claire-de-la-Lune-09-08.mp3

[507] Harald Haack, Die erste Klangaufzeichnung. Eine Audiografie, *online* http://newsbattery.blogsport.de/2008/05/07/die-erste-klangaufzeichnung-eine-audiografie

a completely new kind: digital sampling.

As the primary scene of sonic media memory, almost immediately after its invention, the Edison phonograph was announced in the journal *Scientific American*. It obviously triggered phono-archival phantasms (in the Romantic tradition of the historian of the French Revolution Jules Michelet, who in early Nineteenth century believed to hear the murmurs of the dead in the archives), as a true *Lautarchiv*: "That the voices of those who departed before the invention of the wonderful apparatus <...> are for ever stilled is too obvious a truth; but whoever has spoken or whoever may speak into the mouthpiece of the phonograph, and whose words are recorded by it, has the assurance that his speech may be reproduced audibly in his own tones long after he himself has turned to dust. <...> A strip of indented paper travels through a little machine, the sounds of the latter are magnified, and our great grandchildren or posterity centuries hence hear us as plainly as if we were present."[508]

Natural language is evasive, liquid, in itself unrecordable beyond the bodily range, but technical media (different from alphabetic phonetic writing which "freezes" the human voice into a range of a very limited symbolic code) are able to de-freeze recorded voices in almost all frequencies by re-play. After two millennia of supremacy of the phonetic alphabet there are new kinds of cultural technology in sound recording.

There is a record in the Vienna Phonograph Archive of emperor Franz Joseph I of Austria-Hungary written deep into the wax cylinder (a recording from Bad Ischl, 2nd August 1903). At this point, you probably expect me to play this recording. There is a reason why I don´t, since I want to prove that sound recording has already developed a true media memory which differs from the remembrance of its content. The experiment is very simple: Please imagine yourself the phonographic recording of His Majesty´s voice. I am sure that whatever you think the timbre of his voice sounds, you will acoustically hallucinate as well the scratching, the noise of the recording apparatus.

True media archaeology starts here: The phonograph as media artefact does not only preserve the memory of cultural semantics but stores ist own past *technical* knowledge as well, a kind of frozen media memory embodied in engineering and waiting to be listened to by media-archaeologically tuned ears.

One step further in the experiment, emperor Franz Joseph's actual statement can be quoted. Significantly, this statement - which is one of the first voice recordings preserved at all - tuns out to be the pure message of the medium. When a new technical medium emerges humans are very aware of its technicality (which afterwards, when it becomes mass media, tends to be forgotten in favor of so-called "content"). The emperor expresses his joy to literally "incorporate" his voice into the Vienna phonograph archive.[509] Indeed we are able, today, to listen to human voices which exterminated hundred years ago, by applying laser reading of the wax cylinders which do not destroy its source in the act of re-play. But once more, what we hear is not only the message (the emperor's enunciation) biut as well noise (the phonographic

[508] Anon. (The Editor), A Wonderful Invention - Speech Capable of Indefinite Repitition from Automatic Records, in: Scientific American, November 17, 1877, 304. See chapter 6 "A Resonant Tomb", in: Jonathan Sterne, The Audible Past. Cultural Origins of Sound Reproduction, Durham / London (Duke University Press) 2003, 287-334 (297 f.)

[509] "Es hat mit sehr gefreut, auf Wunsch der Akademie der Wissenschaften meine Stimme in den Apparat hineinzusprechen und dieselbe dadurch der Sammlung einzuverleiben."

scratch). That is what the medium tells us. The noise of the wax cylinder itself which the record articulates whenever it is being re-played is not discursive (cultural) but media-archaeological information of the physically real event. Let us listen to this attentively and not exclude it hermeutically like in the proverbial Cocktail party effect of auditory communication between humans.

With the micro-physical *close reading* of sound, the materiality of the recording medium itself becomes archivally productive. Complementary to musicological hermeneutics the media-archaeological ear listens to the poietics of signals.

Different from passive symbolic writing systems like the phonetic alphabet which still require the human mind and imagination to become "alive", the power of signal-based technical media lies in their ability to actively (re-)create real presence. Let us quote once more from Bartók's comment on his transcriptions of recordings of Yugoslav oral poetry from the 1930s: "It gives you a thrilling impression of liveliness, of life itself" <op. cit.>.

Media as active archaeologists

All of the sudden, audio recordings are not just archival objects any more, but media decoders become active archaeologists of past sounds themselves.

The frozen voices on the analogue, vulnerable storage medium of wax cylinders are currently being de-freezed by digital means. The Berlin Society for Applied Informatics has developed a method to gain acoustic signals from negative traces of galvano-copies from Edison-cylinders by opto-endoscopic „reading“ - scanning visual information into sound.[510] Making stored acoustic waves actually sound does not demand rhetoric imagination but on the contrary a hermeneutically distant ear, an exteriority of interpretation which only the *aisthesis* of the opto-technical scanner can provide.[511] Technical media provide a different option of reading: listening without (premature) understanding. The archaeological ear tries to mimick this ascetic confrontation of signals, resisting the narrative temptations.

With the media mystery of the recordability of the physically real of sound and images, humans get a multi-media mirror effect (in Lacan´s sense), sublating the clear-cut difference between presence and absence, present and past. It is possible, today, to listen to music-ethnographical play-backs in almost exactly the same quality as the natives once experienced in the past. Only the media-archaeological operation of opto-digitally reading the inscribed traces makes the otherwise unaccessible sound recording audible again. We can *see* a spectrographic analysis of an ancient sound recording - a straight look into the archive.[512]

New options of sound retrieval

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[510] See Gerd Stanke / Thomas Kessler, in: Artur Simon (ed.), Das Berliner Phonogramm-Archiv 1900-2000. Sammlungen der traditionellen Musik der Welt, Berlin (VWB) 2000, 209-215

[511] See Jeffrey Sconce, The voice from the void. Wireless, modernity and the distant dead, in: International journal of Cultural studies Vol. 1, no. 2 (1998), 211-232

[512] See the spectrogram of a digitally reconstructed recording of Wedda songs from Ceylon 1907 on http://www.gfai.de/projekte/spubito/index.htm

The notion of the sound archive is in transition. As long as there have been symbolical, score-based archives only, the phantasma of recording the acoustically real (predominantly the human voice) has generated imaginary forms of memorizing sound in supplementary ways.

Re-animation has for long time been *re-reading* - a historians´ syndrom.[513] Stephen Greenblatt once openly declared his *new historicist* impulse: "I began with the desire to speak with the dead."[514] This prosopopoietic desire takes place even against the better knowledge that every dialogue with the past only echoes one´s own voice. The textual *gramophone* (written letters) inevitably belongs to the realm of the symbolic which is the order of the archive, different from the immediacy of the real physically indexial trace (rays of light on photography or tracks of sound on recording media). These new kind of technical memories are archives or libraries no more.

With the emergence of the phonograph, this new type of records was still subjected to forms of inventorization and administration which were developed in the long-time context of paper-based archives.

With the necessity of digitizing phonographic records in order to preserve them against physical, media-archaeological entropy, a new epistemological option emerges which demands media-theoretical attention.

(Multi-)Media archaeology points out the discontinuities which arose with the invasion of audiovisual records in traditional archives, libaries and museums in the twentieth century, resulting in a rethinking of the options of retrieval under digital media conditions - transcending the notion of the archive itself by the technical and cultural application of stochastic order out of media-immanent signal disorder, that is: search operations such as similarity-based sound retrieval. Let us thus have the digitization of analog sound carriers from the past not just be a necessity in order to preserve endangered cultural heritage, but re-think this digitalized records in terms of aesthetic and cognitive options opened by the mathematicized sonosphere itself, liberated from the traditional archival metadata restrictions towards a truly media-immanent naviation within the sounds of the past.

AS SLOW AS POSSIBLE? On machinic (non-)sense of the "sonic present", and on digital indiffera/ence towards "time"

Introducing tempor(e)al sonicity

The concept of "implicit sonicity" does not refer to the acoustic content of sounding matter or other vibrational events but to its medium massage which is its temporal form, as becomes evident in Norbert Wiener's cybernetic interpretation of the organ tone, and from John Cage's composition *Organ²/ASLSP*. Slowing down high-frequent oscillations from the ultra-temporal to the sub-temporal level of perception is an equivalent to cooling down temperature. An organ pipe with low frequency dissolves into discrete pulses at around 16 Hz (Norbert Wiener 1948).

[513] For this metaphor of the historian´s task see Karl Lamprecht, Paralipomena der deutschen Geschichte, Vienna 1910, 4

[514] Stephen Greenblatt, Shakespearean Negotiations. The Circulation of Social Energy in Renaissance England, Berkeley 1988, 1

John Cage composed a musical piece for organ (originally written for piano in 1985) called ORGAN²/ASLSP, with the acronym ASLSP expressing "as slow as possible". In its installation at the Burchardikirche in Halberstadt, it is meant to last from 2000 (start) to 2639.

Ontological reflection on "time" has been a central domain of philosophy, art, poetry in cultural history so far. But once the discursive vocabulary of "time" is replaced by corresponding technical terms, the totalizing term implodes into a delicate multitude of techno-mathematically differentiated operations. In that sense, the verbal *ekphrasis* of the "slowness" theme may be substituted by techno-mathematical *termini technici* like signal delay / *delta-t*, and (a)temporal storage as suspended channel of transmission. From the media-archaeological point of view (in contrast to phenomenology), electronic media do not even make a qualitative but just quantiative difference between time scales which appear to the "inner time consciousness" of humans like "slow" or "fast". In terms of Digital Signal Processing, a high or low tone are not primarily processed in temporal terms but as numeric frequencies. "Slowness" becomes just a metaphor when applied to the techno-logical sense of time. Fourier's implicitely "sonic" analysis of vibrational events made the temporality of world-signals symbolically calculable which, in cold calculation, allows for electro-acoustic time stretching. Storage (beholding the end) turns out as a slowing down of transmission, in frozen vibrations, and frozen voices.

Substituting ears for the missing time sense

For human sensation, the surrogate for the missing sense of time is the ears. Because of the comparative slowness of acoustic signals, the privileged human organ for time-critical perception is binaural hearing. "Interaural time differences arise because of the distance between the two ears. Since the speed of sound is relatively slow <...> there is a significant interval between the time a stimulus arrives at one ear and then the other."[515]

The slow signal run time of acoustic waves even led to the reversal of the cause-effect relation of combat noise in technological warfare - reversed time. When in Second World War a German A4-rocket hit London, the articulation of its acoustic near-coming already lagged begind the destructive event itself. No longer is a danger previously being announced; the sonic barrier is broken.

For human ears, there is no sound any more below 16 Hz. Even if sound as mechanical vibration *is* "slow" a priori, compared to visual presence based on high frequency, "radio"-like electro-magnetic waves. The speed of light results in almost immediate "live" signal transmission - whereas only acoustic sensation, based on slow run-tíme in mechanically elastic matter, becomes recognizable as time event for humans at all. From that slowness, the phenomenal sense of time arises.

A machine has no understanding of "sound" which is a phenomenological category only for humans. An operative digital mechanism only knows implicitely "sonic" timing since it consists of rhythms, pulses, numerical frequencies, just like analog recording media "know" time signals.

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[515] Purves (ed.) 2008: 162

Understanding slowness: Wiener's harmonical analysis and the limits of the organ

With an ultra-slow turntable on a record player, the pick-up reveals sound no more, rather the granularity of the recording medium itself such as shellack. The noise of the apparatus itself becomes audible when signal processing slows down. The recording medium registers movement with indifference - just like Daguerre's early long-time exposure photography of rue du Temple in Paris resulted in a humanless scene, or Hiroshi Sugimoto's long-time exposure photographies of movies resulting in the pure white noise of the theatre screen.

A less phenomenal but more epistemic form of slowing down sound is its mathematical analysis, when the focus is not on its musical content as cultural aesthetic form, but rather on its medium message as sound matter. Norbert Wiener's lecture at University in Göttingen 1925 expressed some paradoxa of Harmonic Analysis: „the breaking up of complicated motions into sums of simple oscillations"[516]. Thereby, implicit sonicity becomes the model case of processual media knowledge. „Vibrations can be characterized in two independent ways, namely, according to frequency, and according to duration in time“ (Wiener ibid.).

In mid-19th century, Léon-Scott created his "phonautograms" as slowed down graphical inscription of speech for a close analysis of the signal event. In media archaeological aesthetics, for the *analytic* purpose of "close reading", technical processuality is reduced to the archaic by "monumentalizing" the signal moment, slowing down it down, even freezing it, like xxx Gordon's almost chrono-photographic slowing down of Alfred Hitchcock's *Psycho* to 24 hours, showing two frames per second,

The acronym of the Association for the Study of the Arts of the Present (ASAP) can be deciphered "as slow as possible". What if, instead of extending the duration of the compositon, the tonal pitch itself is radically "slowed down", replacing endurance by decreasing the frequency- as (s)low as possible, in accordance with Stockhausen's tonal analysis of "as time goes by ..."[517].

This corresponds with the rather neglected (but visible exposed) slowing down of the bellow action providing the air pressure for an organ pipe to generate tones at all (which has actually already been replaced by constant air pressure provided by an electric motor) from - tone to pulse to scratch. Only in extremely slow frequency, the pulsed, therefore "numeric" character of harmonical sound becomes audible, as becomes apparent in the lowest register of an organ ranging 16 cycles per second. In human perception, sound transforms into a series of discrete impulses; in revers, it such a tone is truck only one twentieth of second, there is no sound emanating at all, rather violent air pulses. As notified by Norbert Wiener, the lowest register of an organ „it will not sound to the ear like a note but rather like a blow on the eardrum“ <545>, as pulse sequence, rather telegraphy than telephony: „the complicated mechanism of the reflection of impulses which is necessary to make an organ pipe speak in a muscial manner will not have a fair chance to get startet“ (Wiener ibid.). But this only counts in phenomenological reasoning. The technical medium, on the contrary, is never lost in the illusion of a continuous tone, but always "understands" it for what is physically is: a sequence of repetitive signals inbetween pulse and waveform. With an organ, there are mechanical limits of playing a piece "as slow as possible": With a "quarter note (lasting 1/8th of a second) to be played on some instrument, at the very low frequency of 5 oscillations per second, not even one oscillation will

[516] Wiener 1964/1976: 544

[517] Karlheinz Stockhausen, "Wie die Zeit vergeht ...", in: xxx

be completed, and the air will be pushed, not set into vibrations."[518] In a fast jig (a lively piece of music in the style of a baroque dance) the notes are of short duration: "A fast jig on the lowest register of an organ is in fact not so much bad music but no music at all."[519]

As Slow as Possible / Organ²/ASLSP (Cage)

By his neographism *différance*, Derrida defines the deferral of meaning in any processes of signification, a continual postponement of signification whilst the signified can never be achieved.[520]

[Under the programmatic title *Beholding the Big Bang* (2009), Arthus Ganson constructed a time keeping machinism which starts with 200 cycles of an indented wheel per minute; this movement is sucessively translated and slowed down by sucessive wheels. The last wheel, though, which will be addressed only in thousands of years, is immutable, closely imbedded in a concrete block.[521] Does the first wheel, through its very materiel embedding in the whole system, have a *dissipative* sense of the ending from the beginning, just like the groove on a vinyl record, from the beginning, is already transiently linked to its ending in a repetitive loop?]

A musical performance tends to defer its very ending, for which the Halberstadt installation of Cage's piece for organ is an excessive instantiation.

John Cage's composition ORGAN^2/ASLSP in its 8 page score notation itself is timeless, since it is enocded into the symbolical regime. Such a musical score is usually interpreted as duration of single tones or chords on an enduring, equally sustained pitch; the violin key provides for pitch in terms of standard chamber pitch ("Kammerton") "A".

Fig.: Score of ORGAN^2/ASLSP

Cage's score notation remains symbolic, but the extended bars indicating the endurance (Bergsonean *durée*) of single notes already rather remind of a kymographic registration of the real time signal. Jules-Étienne Marey, in his *Methode graphique* (1868), had already compared his graphic method to the musical notation.

With its 639 year of endurance beyond human perception, such a composition looses ground with / in the entropic arrow of time as irreversible direction. The cultural, artistic approach to *As SLow aS Possible* allows for loose coupling of associations invoked by Cages composition and its actual Halberstadt site specific organ installation by the John Cage Organ Foundation

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[518] P. R. Masani, Norbert Wiener 1894-1964, Basel / Boston / Berlin (Birkhäuser) 1990, 116

[519] Norbert Wiener, I Am a Mathematician. The Later Life of a Prodigy, Garden City, NY (Doubleday) 1956, 106, quoted after Masani 1990: 116; transl. into German Düsseldorf / Vienna (Econ) 1962; reprint Frankfurt / M. and Hamburg (Fischer) 1965, here: 88 f. on "Gigue", in chap. 5 "Die Zeit meiner Auslandsreisen", 76-91

[520] See https://en.wikipedia.org/wiki/Diff%C3%A9rance#Temporal_delay, accessed 30 August, 2017

[521] Exposed at: Labyrinth::Freiheit, 2009, Festung Franzensfeste, Italy; documented in the catalogue, Bozen (Athesia Verlangsanstalt) 2009, 128f

(aslsp.org), while there is a tight coupling of philosophical reasoning and actual technologies in re-thinking its challenge in techno-epistemological terms.

Within the experience of actual interpretations of Cage's ASLSP for piano (1985) and ORGAN²/ASLSP (1987), the question arose how long is "as long as possible" for organs? The debates revolved around the "decisive" - in fact time-critical "question of what would be the most convincing criterion for calculating the duration of ORGAN²/ASLSP"[522]. While the sound of a piano stroke decays, "what happens when the sound of the organ can be sustained as long as desired?" (Bossert ibid.). A performance lasting several hundred years transcends human experience of time - which is a true media time perspective, media-archaeological chrono-poetics. In an autobiographic lecture, Cage once professed his intention that such an *oeuvre* will transform into a non-personal event - suspended from both the composer (Cage) and the individual organists. The life span of a single organist, by extending the rehearsal to 639 years, by necessity is replaced by the expected life span of an organ as technical *organon*. Cage's notation of ORGAN²/ASLSP is not necessarily addressed to human time consciousness at all, but rather requires the media-archaeological non-sense of time.

The enduring organ tone is isomorphic with technical sounds emanating from loudspeakers. Electro-acoustic avant garde circuits like the Theremin fundamentally transformed the temporality of Western music. Sound of synthesizers is pure electric alternating current; it does not pass away like the natural tone, but persists, stays, keeps, lasts.

"Aionic" time differs from the "kairotic" time-criticality of the key attack at any "tone change" event. Every tone will be enduring for years but will be ending; this ending though can not be experimented within human time life spans and thus appears like eternal. The sonic drone installed in Burchardi church since 2001 is a way to make *sublime time* audible.

While the ideal sine tone extends from infinity (past) into infinity (future) - an *aevum* in terms of medieval scholasticism -, its embodiment in the real world can only be an approximation, an enduring intonation "as long as possible". The Buchardi church ASLSP organ installation actually hits the dilemma of Fourier analysis, its hypothesis of an ideally eternal periodicity of sine tone oscillations, which in any actual embodiment by mechanical or electronic instruments is subject to nonlinear distortions. Any key "attack" (well termed a "transient") actually - even if abruptly - evolves and disappears in time. An organ needs a key as relay or switch, to trigger the air pressure impulse; thereby the transient momentum of time-critical control is combined with principally endless duration.Any event (narratively defined by a beginning and ending) unfold temporality, while an endless oscillation is timeless, a transformation of temporality into a pattern.

The Halberstadt installation began on September 5th, 2001, with a pause; only the electronically operated, switched-on Windmaschine under the bellow was audible.[523] What if the electric current supply is interrupted? The answer will be authentic Cagean "silence".

[Only slowness makes the sonic vibration countable - while at the same time, the audible

[522] Christoph Bossert, What Prompted the Halberstadt John Cage Organ Project?, in the DVD edition booklet of the experimental film *(JC{639})* by Sabine Groschup (A 2006 / 2012) on the installation of Cage's composition at St. Burchardi Church in Halberstadt, 2013, 41-59 (53)

[523] Wulf Herzogenrath, Zeit - Klangdauer - Ewigkeit: John Cage in Halberstadt (2001-2640), in: DVD edition booklet Groschup / Weckwerth (eds.) 2013, 60-65 (64)

disappears. Marin Mersenne, in an excess of the ancient monochord, extremely slowed-down the vibrational string, by a tight rope expanded between the walls of a courtyard in order to make its swinging visible, thus: countable, mathematizable in dynamic ways - as opposed to the rather visually oriented, Pythagorean geometry of spatial integer number ratios of musical intervals.

The analog wave form can be numerically approximated by converting (sampling) the signal from the time domain into the frequency domain, which is calculation, re-embodied by digital pulse processing - the very clock-time which both Bergson and Heidegger criticized for missing the essence of time itself.

Seen under a time lense, any sound is repetitive already. Its periodic repetition makes it almost timeless. The enduring organ tone comes close to Fourier Analysis since it is ideally "timeless" In his publication of 1822, Fourier insists that his mathematical decomposition of a complex sound into its single sine waves is mighty enough to describe not only slowly varying processes like temperature but extremely volatile phenomena such as cultural articulation which is sound. Fourier Analysis discovers the eternal in the most ephemeral (while the tempoReal takes revenge with transient signals arising from any physical implementation of sine waves).]

[In Philipp Glass´ minimalistic music compositions, "[t]he constant beat and yet subtly shifting rhythmic cycles over a seemingly static harmonic structures gives the listener a heightened sense of time and, instead of long development sections, progression is achieved through the increasingly complex repetitions and overlapping lines"[524] - from time-based art forms (music, dance, theatre, literature) to time-basing media arts. Another minimalist musical style "emphasizes the use of sustained or repeated sounds, notes, or tone-clusters – called drones. It is typically characterized by lengthy audio programs with relatively slight harmonic variations throughout each piece compared to other musics. La Monte Young, one of its 1960s originators, defined it in 2000 as 'the sustained tone branch of minimalism'".[525]]

Every tone change in the Halberstadt organ installation is itself abrupt, not slowed down itself. There is an inherent paradox in the tone change of the performance extended to 639 years: "Anyone who is present for a sound change in the Burchardi church is confronted with the fleetingness of the moment when a pipe falls silent or with the sudden entrance of a new tone. On August 5, 2011, two deep tones entered with this kind of suddenness. But these tones will resound for so long that they will have exceeded the lifespan of many of those present at this sound change when they fall silent again."[526]

The reverberant room acoustics of a cathedral already reminds of the *delta-t* in acoustics. According to Charles Babbage's *Ninth Bridgewater Treatise*, a sound never disappears completely; even the originary "big bang" in universal time can faintly the traced by ultra-senstitive measuring technologies of traces of graviational waves in Fourier analysis. Such reverberations are now actually sonified by physicist Karsten Danzmann, turning the "big

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[524] Christopher Bowers-Broadbent, Booklet to Compact Disc Philipp Glass, Music for Organ, xxx

[525] http://en.wikipedia.org/wiki/Drone_music; accessed July 2012, referring to La Monte Young, "Notes on The Theatre of Eternal Music and The Tortoise, His Dreams and Journeys", 2000, 27; www.melafoundation.org

[526]Bossert 2013: 57

bang" acoustic metaphor into sensible perception.

It is sonic temporality which allows humans to comprehend the ontological concept of existence as being-in-time. In his *Syntagma Musicum* (1614-1620), organist Michael Praetorius related the symbolic order of the length of notes to the mechanical beat of the wheeled clock.[527] Vol. II of *Syntagma Musicum*, De Organographica (1619), illustrates the first Halberstadt (dome) organ introducing the 12-tone Octave key manual from 1361. From that year derives the calculus for the time-reversed extension of the Cage composition from 2000 onwards. With the metronome of Johann Nepomuk Maelzel (Vienna 1814), musical beat found its own medium, setting the terms on which the micro-time of physical acoustics would later become comprehensible through electro-technical measurement, “the necessary greater exactness [of which] is obtained by the electric current itself"[528].

[Mechanical time keeping itself is slowed down by friction: the moment of contact between the suspended pendulum and the actual clockwork. Damping of the clockwork signals (like in any mechanical vibration) occurs unless they are neg-entropically kept constant by negative feedback circuitry. There is always a loss of energy in oscillations. This *momentum* asks for description "in strictly thermodynamic terms, as a dissipative system"[529]. Only since Huygens, "through isochronic oscillation the pendulum can exist as the autonomous embodiment of natural or physical time"[530]. The motions of the pendulum and the moments of its contact with the escapement build "a cycle which converts potential energy to kinetic energy, and energy to information" (Mackenzie ibid.). In information theory, though, Boltzmann entropy is replaced by Shannon entropy, undoing the time arrow.]

There is a decisive difference between Cage's first composition of ASLSP for piano as percussion instrument like the ancient monochord (1985), where the duration of single chord stroke is limited by the vibrational force (volatile, with "sense of ending"), and the mechanism of an organ as aerophone which allows for principally eternal duration as long as there is air pressure[531] - which makes the organ isomorphous to the electro-acoustic synthesizer, approaching the ideal wave form. The almost Bergsonean sonic *durée* in the Burchardi church is only occasionally interrupted by occasional "tone changes" as event - a chronopoetic cultural shift of emphasis from human time experience to media tempor(e)ality.

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[527] Grete Wehmeyer, Prestississimo. Die Wiederentdeckung der Langsamkeit in der Musik (Hamburg: Kellner, 1989), 15

[528] Hermann von Helmholtz, On the Sensations of Tone as a Physiological Basis for the Theory of Music (Whitefish, MT: Kessinger Publishing, 2005; orig. 1863), 398. See also Scherer, “Musik und Echtzeit,” 362

[529] Adrian Mackenzie, The Technicity of Time. From 1.00 oscillations/sec. to 9,192,631,770 Hz, in: Time and Society, Bd. 10, Heft 2/3 (2001), 235-257 (255, note 16), referring to: I. Stengers / D. Gille, Time and Representation, in: Power and Invention. Situating Science, Minneapolis / London (University of Minnesota Press) 1997

[530] Mackenzie 2001: 244

[531] Herzogenrath in DVD booklet, 63

In the Halberstadt installation, an incommensurability between the sensorial physical experience of acoustic space and its textual description of the enduring event arises.

In Cage's composition ORGAN²/ASLSP, every tone change counts as "event", even if their is no human consciousness which it takes to integrate a sequence of discrete tonal steps into the sensation of a temporal musicial horizon called "melody" by re- and protention (Edmund Husserl) since it exceeds the human perceptional time-window of "the present". Every tone change is staged as an event by a human operator. Why not turn the idea upside down and let an automatic player organ step-wise unfold the tone sequences, with a start / stop mechanism as an interface pre-positioned to the actual Burchardi chruch organ? Such a sequence, like any algorithm, is timeless in itself.

The earlier work *ASLSP* from 1985 had been written for a piano competition. A typical performance of the piano version lasts 20 to 70 minutes; Cage consciously restrained from indicating "of exactly how slowly the piece should be played". No two performances would be the same in its temporal interpretation - which makes all the difference to musical automats like the Welte Mignon Player Piano with its recording and replay mechanism technical where the external time base is indicated chronometrically. Conlon Nancarrow's punched card-based compositions *Studies for Player Piano* allow for both un-human timing and unfolding of musical sequences in time[532], mechanically (in principle) endlessly extensible.

[When Italien priest Angelo Barbieri, from the 1930s onwards, developed automatic player organs to enable such music during a Catholic service even in the absence of an organist, the Vatican did not grant permission of inanimate machine timing in liturgy.[533]]

[Sonification of / as time: AION, resonance, drones, minimal music]

Radio-active waste is physically treated in terms of "half lives", that is: slow decay of energetic states. Jakob Kirkegaard's audiovisual installation *Aion* (DVD), in 2006, took place in the abandoneded rooms of a nuclear reactor area, unfolding the temporality of space inside the Zone of Exclusion in Chernobyl, Ukraine, "an area haunted by an invisible and inaudible danger, amidst the slowly decaying remains of human civilization. The sound of each room was evoked by an elaborate method" which stems from Alvin Lucier's seminal magnetophonic installation *I'm sitting in a room*: "in each room, Kirkegaard made a recording 10 minutes and then played the recording back into the room, recording it again. This process was repeated up to ten times. As the layers got denser, each room slowly began to unfold a drone with various overtones."[534]

For the visual representation of Kirkegaard's experiment, "two of the four rooms employ a recording technique parallel to the sonic layering. A video camera was placed on one particular spot in the space and it recorded non-stop from there. This recording was then projected and recorded with another camera tine and time again. In this process, some of the rooms turned darker, others turned brighter – they reveal themselves on the screen, they dissolve into white

[532]See Lorenz 2012: 36

[533] See Giorgio Farabegoli, Angelo Barbieri's Organs, in: The AMICA Bulletin (Automatic Musical Instrument Collectors' Association), vol. 50, no. 6 (Nov. / Dec. 2013), 261-275

[534] http://fonik.dk/works/aion.html, accessed July 2010

light or they disappear into darkness. For the two other rooms video feedback was used to under- and overexpose the image. Jacob Kirkegaard’s AION is a sonic and visual installation that considers time, absence, and change inside the Zone of Exclusion in Chernobyl, Ukraine" (ibid.).

If the present is mirrored by itself, like in Dan Graham's closed circuit video Installation *Presence Continuous Past* (1974), a slow delay (in fact eight seconds) results in an irritation of the present itself.

The affordance of electromagnetic recording induces aesthetic and epistemological experimentation with time such as AION. "Kirkegaard's "sonic time layering" refers back to Alvin Lucier's work "I am sitting in a room" [1970] in which Lucier recorded his voice and repeatedly played the recording back in the space in which it was recorded"; the sound Kirkegaard recorded in Chernobyl in October 2005 and folded upon itself is a way to make the nuclear sublime audible.

When decades after the Tschernobyl nuclear desaster event Kirkegaard explored the phenomenon of radiation by sonic time-layering, this was a sonification of the temporal sublime itself, "recording, mirroring and layering the silence of four radiating spaces he aims to unlock a fragment of the time existing inside the zone". Sound, primarily, is a sonification of time, whose existence is extricably bound to such reverberative (wave form signals) or repetitive (discrete pulses) events.

If reverberative sonic feedback and its technical re-recording is accelerated, it becomes a *drone* (with the resonant circuit within a radio being its pures form). "Musicall speaking, the physics of a broadcast is a type of drone."[535] Drone sonicity suspends time by its very iterative structure. Drone music is reverberative, "sustained sound", a transformation of sonic temporality into space, like the moving still ("Photofilm") in cinematography. The technique of the so-called *freeze frame* is important not just to cinematic negotiation with time, but in a more general sense when it comes to objects which do not consist of elementary units but only by repetitive action.

Electro-acoustic time-stretching / -compression

With electro-acoustic timestretching software device, "[t]he timeline typically stratifies the on-screen workspace into a metric grid, adjustable in terms of temporal scale" - be it hours, minutes, seconds, musical bars or frames per scene. Such a functional timeline, "zooming in and out, from the microsonic field of the sample to the macrosonic domain of a whole project, provides a frame for possible sonic shapes to be sculpted in time"[536]

Sonic timestreting, in spite of being derived - since Gabór's "acoustic quanta" sound grains - from the highly quantified, metrical and mathematical realm of the digital time-discretness criticized by Bergson, opens up alternative temporal possibilities which are different from linear progression and - in an unexpected dialectic return - more evocative of Bergson’s conception

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[535] Bill Viola, The Sound of One-Line-Scanning, in: xxx

[536] Steve Goodman, entry "Timeline (sonic)", in: Matthew Fuller ed., Software Studies: A Lexicon, Cambridge, MA (MIT Press) 2008, 256-9 (256)

of *durée* itself.[537] Within the realm of techno-mathematical "discrete time sampling" (Goodman), "durational time" ironically emerges out of the most discrete micro-temporal segmentation.

In his composition *9 Beet Strech*, Leif Inge slowed down Beethoven's "Nineth" by granular synthesis to (online) 24 hours, applying real time pitch shifting technology.

[It has been the option of transposing a male voice into a female one in realtime without Mickey Mouse effect that once induced Friedrich Kittler to advance from electro-acoustic synthesizer wiring to coding a microchip in time-critical Assembly language.]

Jem Foiner composed a piece for millenia, the *Long Player*, while by mathematical combinatorics, Benjamin Heidersberger's *Pentatonic Permutations Player* discretely calculates the time of the universe itself: an algorithmic piano composition that started 14 billion years ago and will continue another 16 trillion years, tagging every moment of time. After the last permutation the piece will stop.[538]

Different from the time-stretched Cage organ installation at Halberstadt, once tones within the signal time domain have been computationally sampled, they do not exist in time at all any more, rather in its reversal, the frequency domain, which makes it accessible to numeric algorithms.

"In time series analysis, dynamic time warping (DTW) is an algorithm for measuring similarity between two temporal sequences which may vary in time or speed. [...] DTW has been applied to temporal sequences of video, audio, and graphics data"; any data which can be turned into a linear time series can be analyzed with DTW. It is a partial time shape matching application. "Sequences are 'warped' non-linearly in the time dimension to determine a measure of their similarity independent of certain non-linear variations in the time dimension."[539]

Ableton Live sound editing software allows for rhythm manipulation. When a rhythm is played by a real drummer, this beat feels human exactly by not being always just in time. In order to layer other rhythms of clips with the present one, Warp Markers allow to bring various loops into sync with one another. In reverse, alternative software allows to re-humanze electronic drum machines[540] - refamiliarizing algorithmic music with rhythm.[541]

Very low frequencies: frozen voices, frozen vibrations

The slowing down of technical signal processing, and even the "freezing" of the moment, is in alliance with a media-archaeological momentum. In its incubation phase, photography

[537] See Henri Bergson, Creative Evolution (1907) trans. Arthur Mitchell (Mineola, NY: Dover Publications, Inc., 1998), 4

[538] What it sounds like: https://soundcloud.com/benjamin_heidersberger/ppv_20161019mp3

[539] http://en.wikipedia.org, entry "Dynamic time warping", accessed August 5, 2014

[540] See Eshun, xxx, and the project draft xxx by xxx Zoeller

[541] See Shintaro Miyazaki, xxx

demanded long-time-exposure which made architecture, fossils and sculptures its favourite objects, ignoring animal motion - until with new chemical means of fast light impression (gelatine), this eternity escalated into the proverbial photographic "click" which turned photographical timing upside down, resulting even in chronophotography itself.

Florens Chladni, in his *Akustik* around 1800, made visible the "Klangfiguren" by freezing them into print. Slowing a high-frequency technical process down which is not immediately accessible to the human senses is truly process-oriented ontology. The rhythms and tempor(e)alities unfold as the *chronopoetics* within the machine. There are oscillations which can not be received by the human ears but rather represent the "implicit sonicity" of technical timings. Beyond (or below) the acoustic "content", the real "message" of such processuality is its time-figures. In ancient Greek music theory, Aristoxenos (in his fragment on *Rhythm*) coined the term "chronoi" (times, in the plural) for such sonic articulations in micro-time.

Early science fiction, *Baron Münchhausen's Adventures*, chap. 5, tells about the defreezing of trumpet signals (which are physical vibrations of a medium indeed) literally frozen in winter like water waves at the shore, defreezing. They defreeze at a warm oven as sound[542] - sonic time in latency. The signal structure of defreezing is the sinusoidal wave indeed, the *tide*. This links is to literally the epistemological key term "Zeit" itself. "Unfreezing the captured vibrations"[543] in François Rabelais' *Gargantua et Pantagruel* (1532).[544]. A boatsman tells about a frozen lake where the noise and cries of a battle have cristallized in the icy air, waiting to be released in warmer springtime[545] - a fictitious, though plausible anticipation of phonographical sound recording and replay.[546] Charles Babbage, in his *Ninth Bridgewater Treatise* (1837), considered the air as an implicit sonic "vast library" of any vibration ever articulated, a superimposition of sine waves in eternity which can not only be mathematically analyzed (Fourier) but actually be retraced (like Patrick Feaster achives it for "lost sound"[547]). Babbage's speculation is acoustemic.[548]

Imagine the phonographic record of Martin Heidgger's speech *Die Kunst und der Raum* at St. Gallen starting to be slowly activated on a record player, defreezing infra-sonic vibrations, accelerating to uncanny articulations, until a deep recognizable voice slowly emerges from one and the same signal storage medium.

While Fourier analysis of heat waves ideally presupposes timeless signals, in reality (that is: implemented into physical / technical matter), oscillations are subject to increasing decay; they

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[542] August Gottfried Bürger, Wunderbare Reisen zu Wasser und zu Lande, Feldzüge und lustige Abentheuer des Freyherrn von Münchhausen, London 1786

[543] Moore 2010: 291

[544] Chap. 4, LVI

[545] Siehe Moore 2010: 294f

[546] August Gottfried Bürger, Wunderbare Reisen zu Wasser und zu Lande, Feldzüge und lustige Abentheuer des Freyherrn von Münchhausen, London 1786

[547] See Feaster, xxx

[548] As discussed by John Picker in *Victorian Soundscapes*

"die away <...> for which reason they are called transient"[549].

The elementary unit of a technological being-in-time is the time-varying signal. A phonographically recorded acoustic signal, when not being moved, is not in its signal state but a graphic inscription (storage). It becomes an operative media diagram only when turned into a "time object" (Husserl) again[550], being "de-frozen" and transduced by the apparatus movement and the pick-up. The phonographic record waits for the mechanic player to defreeze its signals in a technological act of re-presencing.

In media archives around the globe the films rolls themselves are frozen down in order to withstand time. It takes around twelve hours to dehydrate stored film material in archives of the moving image before they can be viewed in a non-destructive way. The archive here not a metaphor for icy memory, but becomes "cold" media memory itself. Freezing slows down entropic degradation.

Electro-magentic events (like light) occur at regular intervals millions of times, "but what if they repeat merely 10 times, five times, or only once? Identification of the definining limit cycle is elusive with so few cycles. <...> Occasionally, it is virtually impossible to draw a line between a true but transient oscillator and system with properties prone to oscillate: resonators"[551].

Vibrational matter is analyzable into its parameters: amplitude, period, frequency, duration, resonance which is all technical terms substituting the imprecise transcendent signifier "time". Repetition is a challenge to time since it both affirms and questions this dimension. In Aristotle's definition, time comes into existence only by counting.

A machine has no "sensation" of tone (in the phenomenal sense defined by von Helmholtz 1864) but a clear awareness of sonicity as vibrational act of periodic wave forms.

The human optical sense only perceives a fraction ("light") of the electromagnetic spectrum, while high sensitive technical instruments extend human capabilities and detect radiation across the entire spectrum, from gamma to radio waves. Electro-magnetic temporal being ("temperatures") happens in the Ionosphere (indirectly audible by Short Wave Radio) as well as in cosmic background radiation.

Bergson explains that if one does not have sufficient capacity to retain at once the 400,000 million vibrations per second of the electro-magnetic field which defines (roughly) the chromatic band of the colour red, "one could take the case of a sound-vibration too, simply it is less impresive in terms of the frequency and thus less pedagogical"[552]; if, then , one is condemned to capture only one vibration at once, it will take 25,000 years (about) to register red. And of course, this won't 'look red', but be 400,000 million simple shocks. "This is the case, says Bergson, for the 'pure' material point [...]" (Lyotard ibid.).

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[549] Buzsáki 2006: 142

[550] On "temporal objects" ("Zeitobjekte") see Edmund Husserl, On the phenomenology of the conciousness of internal time (1893-1917), transl. John Barnett Brough, Dordrecht (Kluwer Academic Publishers) 1991, esp. 24: "jedwede Veränderung, aber auch jedes Verharren als solches betrachtet" - Henri Bergsons *durée* as well as John Cage's ORGAN^2/ASLSP

[551] Buzsáki 2006: 142

Electronic media can clearly analyze what to humans appear like a continuous tone into its sincle wave or pulse trains. "The question is that of the beating or the oscillation which generates what we call sound. For the naked monad which receives only one beat at a time, there is no synthesis of the succession, and thus no beating. It hears only one wave, and it does not know that *it is only* one wave. Shall we say that if forgets those which have passed? No more than the billiard ball forgets the shocks it has reveiced from other balls"[553]; the answer in human cognition is the perception of a melody by means of a temporal horizon: pro- and retentions as defined by Husserl.

[While research on global climate change is based on long-time measured time series, meteorology aims at short-time prediction - which in a "memoryless", almost ergodic atmosphere is a challenge for discrete hydrodynamic computation. The techno-mathematical answer is Fast Fourier Transform, changing from the time domain (continuous "temperature") to the frequency domain (discontinuous data "clouds").]

For digital machines there is no "time"

"Live" (for analog media) and "realtime" (for digital media) technical signal transmission has become a metaphor for the speed of transfer that accelerates discourses, people and society.[554] Slowing this speed down, delays or even gaps (temporal interrupts) in transmission have become a retro-effective luxury in experiencing the contemporary.

Whereas digital data transmission is much too fast to be perceivable directly to human senses, the archaic telegraph "dots and dashes", when connected to an acoustic mechanism, may serve as a way of slowing down, sonifying the nature of coded signal transmission.

Slowing down or even freezing storage of vibrations and their processual present are just two extreme formulations of one kind of event. Resisting the geological metaphor, there is no "multi-layered temporalities" any more, but no more "time" at all. The situation escalates with Shannon's techno-mathematical definition of information which is - more than ever - the enduring foundation of digital media communication today. In principle (*en arché*), the "bit" is timeless in its lossless, reproducibility and calculability. More than this, binary computation even generates new epistemic time objects, like "ergodic time", "Markov chains", and Norbert Wiener's poetic expression of a "time of non-reality" for the switching interval between two alternating voltage states: a very tempo*r(e)al* in Lacan's sense.

For digital machines, there is no sense of "time"; the finite automaton only knows discrete "states". Therefore no sense of "slowness", but high-frequency, time-critical data processing within the microchips. The very term "realtime" is purely functional in the sense of just-in-time

[552] Jean-François Lyotard, God and the Puppet, in: idem, The Inhuman. Reflections on Time [*L'Inhuman: Causeries sur le temps, Paris 1988], Stanford, Cal. (Stanford University Press) 1991, 153-164 (161). See as well Karl Ernst von Baer, xxx, in: Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kadmos) 2009

[553] Lyotard 1991: 161

[554] Paul Virilio, xxx

production; when addressed to human apperception, it means calculation not too slow to pass within the temporal window of the "present".

II 0N PHONICITY AND S0NICITY (notes):

Case study: "Lautarchiv", Humboldt University

- application of dynamic time warping (DTW) in automatic speech recognition, to cope with different speaking speeds; to warp "verdrehen, verzerren, entstellen"; time warp "Zeitschleife"; L. R. Rabiner / B. Juang. Fundamentals of speech recognition, Prentice-Hall, Inc., 1993, chapt. 4

- cultural *analytics* expressed by spectographs for audio content - a dramatic shift of emphasis from the symbolical textual field to the processing of the real audio signals; voices identified by their very spectral individuality, not subjected to alphabetic registration in written metadata; a signal memory arises from the phonographic record

- media-historiographically canonized „first“ technical, not just symbolical recording of a human voice (children song „Mary had a little lamb“) resulting from the experiment of Thomas Alva Edison with the tinfoil phonograph in 1877; primary scence *re-enacted* by the elderly inventor (Edison) himself, 30 years later by his same / different voice for a sound film. While the recorded signal principally stays invariant over time, the body from which the song originated apparently has aged, being strictly subjected to what is called historical time; Beckett's drama *Krapp's Last Tape* (1958)

- to convince the audience of the sonic fidelity of phonographic recording, Edison Company in 1916 arranged for an experimental setting in the New York Carnegie Hall: "Alone on the vast stage there stood a mahagony 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."[555]

- parallel staging of human vocal performance *versus* apparative acoustic operativity 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" = quoted here 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. Dazu 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. What took place is the chrono-Sirenism of *His master´s voice*, which is the presence-generating "illusion of being present" (Peter Wicke), induced by technical recording

[555] "Edison Snares Soul of Music", in: New York Tribune, 29. April 1916, 3

- "Siren" songs better understood by radio receivers; the revived interest in the acoustic authenticity of the Siren motive in Homer's *Odyssee* re-arose within radio culture, which for the first time made the voice not only symbolically (alphabet) but actually transmissible as signal

- Berlin *Lautarchiv*, as its very name expresses, not just an audio archive of human voices and ethnic songs from the past, but as well an archive of *Laute*, which in German refers to phonetic and sonic, even noisy articulation - that is, all kind of acoustic enunciations. Listening to the records with media-archaeological ears, one detects not only the human speech but the expression of the recording apparatus und storage media themselves - the scratches and the revolving rhythms of the Edison cylinders. In the online-inventory of the *Lautarchiv*, among page-long enumeration of recorded ethnic songs, two artefactual devices are listed which embody the media-archivological condition for listening to such voices from the World War One past at all: items no. (ID) 9311 (type "Plastisches Objekt") *Zwei Tonabnehmer* (electro-magnetic pick-ups)

- on the linguistic field that the first computational algorithms for voice recognition have been developed - as "Umwaldung der physikalisch meßbaren Schwingungsverläufe von Sprachsignalen in elektrische Impulssignale"[556]

- key operation of time-signal-to-frequency transformation: "Schwingungen können durch Folgen von Zahlen repräsentiert werden"[557]; sonicity not reduced to the dynamics of waveforms, but encompasses mathematical operations (and their computing machinic embodiments) as well. "Lautsprachliche Merkmale" (Schnelle) can be differntiated into *vokalisch*, *stimmhaft*, *sonant*, *(ex-)plosiv*, *geräuschhaft*[558]

- target of sonic analytics not speech as semantic content in the hermeneutic sense, but the very materiality of such articulation: the phonetic "Laut" (*phoné*); very name *Lautarchiv* can be deciphered literally, and different from other sound archives this one is especially apt for sonic analytics on the ground of its very "phonetic" target which was inscribed by its original promotor Doegen from the beginning - notwithstanding the circumstances of its coming-into-being in a prisoner camp (Wünsdorf close to Berlin) during World War I. While *Kulturwissenschaft* (cultural analysis) concentrates on this ambivalent historical and discursive context, the media archaeological ear rather listens to the actual media articulation contained in the Lautarchiv itself

- "Tones can be made visible. The oscilloscope, through electrical processes, transforms vibrations of the air into a picture that appears on an illuinated screen. It is the picture of a wave line. <...> An experienced observer can accurately read the aocustical qualities of the tone from the outline of the curce. <...> The one thing he could not in any way deduce from the picture is the dynamic state of the tone. <...> the dynamic, the musical difference, does not appear in the curve" = Victor Zuckerkandl, Sound and Symbol. Music and the External

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[556] See H. Schnelle, Automatische Sprachlauterkennung, in: Kybernetische Maschinen. Prinzip und Anwendugn der automatischen Nachrichtenverarbeitung, Frankfurt/M. (S. Fischer) 1964, 208-219 (208)

[557] Schnelle 1964: 211

[558] Schnelle 1964: 210. See esp. Fig. 1 "Schematische Darstellung der Signalverarbeitung zur Erkennung des Merkmalpaares stimmhaft/stimmlos", in: Schnelle 1964: 213

World, New York (Pantheon) 1956, 22; corresponds with the material, tonally *integrative* engraving of a musical event in the phonographic groove: "The chains of physical events that at every instant give rise to the auditory experience all go back to the same point of origin, the point of the phonograph needle. The motions of the point of the needle are translated, through a number of technical intermediate esteps, into vibrations of a membrane and thus into air vibrations. Like every material point, the point of the needle can make only one movement at one time. <...> The illuminated disk of the oscilloscope shows only one line, no matter how many tones are sung into the microphone simultaneously <...>. <...> what the apparatus registers as *one* wave, we *hear* as *multiplicity* of tones - and as a organized multiuplicity <...>. <...> in our / hearing, this single visible line becomes a combination of lines exhibiting vertical and horizontal relations of the highest cpmplexity <...>. To be sure, mathematical analysis of the shape of the line permits us to deduce the individual waves that are combined in it. Yet <...> our ear accomplishes, effortlessly, continuously, and instantaneously, what costs the skilled mathemtician a considerable expenditure of time and energy" = 1956: 333 f. - until Fast Fourier Transform arrived in digital real-time computing

- techno-metrical analysis of phontic recordings, limited by the signal bandwidth of mechanical sound records from the past (*terminus ante quem*) as compared to electro-magnetic (or sound film) recording

"dictaphone"

- Isaac Pitman, Phonography, or, Writing by Sound; Being a Natural Method of Writing, Applicable to all Languages, and a Complete System of Shorthand, London (Bagster & Sons) 1840

- voice on dictaphone still the human speakter's voice? Does one recognize the bodily source when listening to this audio recording like the dog Nipper once's recognized "His Master's Voice" from gramophone? different from using the dictaphone "function" as "App" on a smartphone, rather enact a recording on a real analog dictaphone; recorded voice audibly gets subject to unintended and entropic accelerations or slowing down since this recording and re-play takes place on an antique analog electro-magnetophonic medium (even though, in order to become part of an Internet website, this recording has to be sampled and compressed into a digital data format which claims to be invariant towards temporal change); dis-embodied voice recording tells as much about the technological biography of the dictaphone itself; eventually subject to forensic speech recognition to authorize the recording and recorder

- tecsonicity (somewhat artificially *das Technosonische* in German, to differentiate it from acoustic sound as *Klang*) referring to the medium message of sonic articulation, which in techno-mathematical media is the unfolding of (at least partially) periodic time signals (electro-magnetic vibrations, digital pulses); temporal isomorphism between phenomenal sound and media-inherent dynamics

Lautarchiv *analytics*

- "Schematische Darstellung der Signalverarbeitung zur Erkennung des Merkmalpaares stimmhaft/stimmlos", in: Schnelle 1964: 213, fig. 1; oscillograms by Brandl, from: Britta Lange, Playback. Wiederholung und Wiederholbarkeit in der frühen vergleichenden Musikwissenschaft, Preprint 321 of the Max-Planck-Institut für Wissenschaftsgeschichte Berlin (2006)

- sonic analytics (provided by Nikita Braguinski) for a recording of the folk Song *Vo kuznice*, 1916 with a chorus of Russian war prisoners; Lautarchiv inventory no. PK135-Mersbach; instead of traditional alphabetical transcription, open source linguistic software like Praat allows for (and incites) new kinds of "archive" mobilization: *signal-based* speech analysis. Under such observation, audio recordings are not just archival objects any more, but become items in an experimental laboratory of presence. This presence is a distorted one, though. Trendelenburg describes the distortions of sound fidelity which are essential features of phonographic and grammophonic records.[559] This is the bandwidth limit of mechanical sound records from the past as compared to electro-magnetic and finally digitally processed recording

- recordings of famous voices (which for political reasons were partly neutralized or even destroyed after 1945); truly phonetical recordings of local speech dialects, based on a set of artificial word sequences in order to achieve formal comparability (so-called Wenker-sentences) with the speed of the recording beeing controlled by a supplementary oscillographic time code, and early recordings for musical ethnology (mostly Africans and Indians from the French and British Army in the World War One *Halbmond* prisoner camp at Wünsdorf south of Berlin)[560]

- phonological target inscribed into the Lautarchiv by its promotor Wilhelm Doegen from the beginning - notwithstanding the circumstances of its coming-into-being with recordings in a prisoner camp. While cultural analysis concentrates on this ambivalent historical and discursive context, with a different epistemological vantage point media archaeology lends its ears to knowledge which can be derived from the actual media articulation contained in the technical archive itself.

- Lautarchiv currently in a dormant state, a "frozen" archive, "cold" storage of recorded voices; wakening it up does not necessarily mean to transfer it into a public museum; activating the store (respectively the data bank) today rather means transforming it into an informatinal space; digital "archive" absorbing all previous media - not materially, but as formats = Kittler 2007: 113

- limits of digital archive-"tectonics": even lossless compression resulting in bandwidth limitations in recorded frequency spectrum

Case Study in sonic analytics: Kurenniemi's audio-diary, re-activated by Constant

- listening to recorded sound through the ears of the algorithms; multiple correlations vs. fixed taxonomy; not single sound files reveiled, but relations within sound bits within, a *diagrammatic* sonic archive

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[559] Ferdinand Trendelenburg, Klänge und Geräusche. Methoden und Ergebnisse der Klangforschung, Schallwahrnehmung, grundlegende Fragen der Klangübertragung, Berlin (Julius Springer) 1935, 51

[560] See Britta Lange, Ein Archiv von Stimmen. Kriegsgefangene unter ethnografischer Beobachtung, in: Nikolaus Wegmann / Harun Maye / Cornelius Reiber (eds.), Original / Ton. Zur Mediengeschichte des O-Tons, Konstanz (Universitätsverlag) 2006, 317-341 (esp. 335f). An almost complete list of the both phonographically and symbolically registered recordings is provided online: http://www.sammlungen.hu-berlin.de/sammlungen/78.

- Kurenniemi's cassette tapes (Philipps-Recorder); analysis of digitized audio-Inhalte with Spectrum sort algorithm (loudness / dynamics in decibel), thereby extracting song-like passages; apply to *Lautarchiv*; separate speaker from (noisy) background; Constant file associative_memory.aif; Herfried Weiser, quasi-phonetic commanding of video cuts by Kittler's articulation

- *sonicity* refering to search algorithms as well: sonic analytics; algorithmic ("automated") tagging (mark-up), kind of endo- rather than metadata from within the medium; oppose / combine with "social tagging" which is non-taxonomic in similar ways; hybrid (non-)classifiction

- algorithmically / automatically tagging "silence" (intentinonal and non-intantional one); "analysis"-tool under sound editing software Audacity: "Silence Finder"; "Effects" option: "Remove Silence"; further: "Echo"; "Beat Finder"; frequency analysis (choice of sampling rates)

- algorithmic annotation with software from computational linguistics: temporalizing phonems, software PRAAT (Netherlands), PLP Laboratory; University of Mons: voice synthesizer; experimentation with the *a priori* of data organization

- Kurenniemi's development of Digital Music Instrument, Associative Memory (DIMI-A), 1969, with its characteristic mode of choosing audio data according to content in the memory, not with addresses / hashing

- by Fast Fourier Transformation, any kind of (digitized) sound is being broken down into discrete time slices / shunks of sound

- according to Fourier, any sound decomposable into its single sine waves which - in reverse - can be expressed (and thus: computatinally addressed) as frequency, i. e.: numbers; sound as addition of tones = drone ("Ge/Summe"), both kymatically and mathematically

- Erkki Kurennimi - A Man from the Future, edited by Maritta Mellais, Helsinki (Finnish National Gallery) 2013; *online*
http://www.lahteilla.fi/kurenniemi/fi/a-man-from-the-future

- http://activearchives.org/wiki/Archive_in_motion_presentation#Audiogrep

- life-logging; cp. Gordon Bell (at Microsoft), project Life Caching

- Kurenniemi's assemblage of different live-recording media (now deposited at the Central Art Archives of the National Gallery in Helsinki). Keeping this legacy "open" requires a rigid archival / institutional backbone on the one side, and stopping making pre-figurated sense by classification on the other, in favour of stochastic, Markov-chain based retrieval

- project *Online Archive: Erkki Kurenniemi (In 2048)* commissioned by Kurator and *Documenta* 13 in partnership with the Central Art Archive of the Finnish National Gallery and Contemporary Art Museum KIASMA in Helsinki

- website of Constant's Kurenniemi project; "logbook" including Constant’s probes into the archive, sample visual data, allowing for interaction with the *data radio*

- multiple correlations *versus* fixed taxonomy; thus: not single sound files are being reveiled, but relations between sound bits from within, a *diagrammatic* sonic archive

- algorithmic analysis driven by source code implemented into operative computers. Constant defines the "active archive" as "[...] strategies and tools that amplify and diversify the *process* of archival work, to actually reveal its technological conditions: "a software-machine, as readable, writeable and exectutable", in an effort to let the material "'speak' for - itself"[561] - which matches, in the digital regime, nineteenth century "analog" enthusiasm of early photography as indexical "self-registration" of nature, or the kymograph as self-registering sonic signals, to archive-based writing of history); beyond traditional historicism: nagivating audio-visual data (once sampled into bits and bytes) from *within*, that is: truly media-archaeologically, suspended from metadata

- traditional archival format for records (spatial order, classification) in many ways necessarily persisting; algorithmization of its digitized records radically temporalized, ephemeral, multisensual, corresponding with a dynamic user culture which is less concerned with records for eternity but with order by fluctuation

- deriving new insights from Finnish artist-engineer Erkki Kurenniemi's audio-cassette-diaries from the 1970s by means of the "active archive", Constant developed a "Spectrum Sort" tool.[562] An audio file is digitized in samples of a tenth second, resulting in a set of dynamic levels. With their strongest values being extracted, a new audio file is being created which is sorted from the lowest to the hightest frequency bands. Thereby the moments when Kurennemi does not dictate speech any more but occasinally starts singing can be identified immediately from the massive amount of his cassette tapes

Listening to magnetic tape recordings

- acoustic evidence: "And if there are gaps within the signal, we can usually organize the incoming signals into a meaningful pattern, or a complete *gestalt*, by filling in those gaps“[563]; Joseph Jastrow's experiments with visual ambiguity around 1900 (figure-grund-ambivalence as perceptional relais); Oliver Stone's film *Nixon - Der Untergang eines Präsidenten* (USA 1995); magnetic tape recording of Nixon´s words in the Watergate skandal: "Nothing here now but the recordings" (William Burroughs). "Although my assistant and I listened to the line repeatedly with great care, we were able to hear neither *on with* nor *off*, but only unintelligible noise. Thus depending on who listens to the line, the resulting *gestalt* is very different" = Esau 1982: 309

- Human eyes and ears tending to overlook and overhear noise as information = Harris 2001:

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[561] Geoff Cox / Nicolas Malevè and Michael Murtaugh, Archiving the Data-body: human and nonhuman agency in the documents of Kurenniemi, to be published in: <Kurenniemi>, MIT Press 2015; online: body_human_and_nonhuman_agency_in_the_documents_of_Kurenniemi (accessed July 15, 2014)

[562] See Jussi Parikka, DIY futurology. Kurenniemi's Signal Based Cosmology, in: Erkki Kurenniemi - A Man From the Future, ed. by Maritta Mellais (Helsinki Finnish National Gallery) 2013, 32-55; http://www.lahteilla.fi/kurenniemi./en/content/erkki-kurenniemi-%E2%80%93-man-future (accessed July 16, 2014)

[563] Helmut Esau, The „smoking gun“ tape: Analysis of the information structure in the Nixon tapes, in: Text. An interdisciplinary journal for the study of discourse, vol. 2 (4), New York / Amsterdam (Mouton) 1982, 293-322 (306)

122, otherwise compressing algorithms for streaming data in computing not acceptable; human hermeneutic preference for *Gestalt*, the filtering out of noise; non-human senses more sensitive to noise but unable to separate from meaningful signal; communication happens not only between humans any more, but in an emerging intra-technological intelligence

- "Nothing here now but the recordings" (William Burroughs); same author: *The Electronic Revolution* (Expanded Media Edition, 1970). "Although my assistant and I listened to the line repeatedly with great care, we were able to hear neither *on with* nor *off*, but only unintelligible noise. Thus depending on who listens to the line, the resulting *gestalt* is very different" = Esau 1982: 309

Frequency analysis: Popular music as technical memory

- turning a passive archive (or collection) composed of silent sound carriers ("Tonkonserven") into an active archive by applying measuring and algorithmic analysis; media themselves becoming "archaeologists" of sounds past

- taking the visible image of grooves in a vinyl record literally, analyzing them as what they apparently are: wave forms

- museological perspective for Musée des Ondes Emile Berliner (former RCA records factory) in Montréal; conceptual focus present already in title: the wave-form; to pick up an essential of what is associated with "analog" media, both mechanical (the phonographic groove) and in terms of electro-magnetic waves (radio / television); the place then will develop reflection upon the relation between wave forms and quantized (techno-mathematical, "digital") sound events; would give the place an importance of media-epistemological dimension

Electrified memory

- non-philological analysis of "oral poetry", when its notation for analysis does not take place in symbolical writing (the phonetic alphabet since the age of archaic Greece, or more recently, musical notation) any more, but by (electro-)physical recording media like the phonograph, Milman Parry's aluminium discs; micro-events in performing oral poetry thus get under consideration, near-discontinuous change, probabilities of transitions, re- and protentions which require stochastic rather than simply statistical analysis

- paradox of "preserving the ephemeral" of oral poetry by transcription of phonographic recording (Parry / Lord, Bowles et al.); documentation by arbitrary, coded, discrete signs is symbolic, while signal recording captures it, at the same time freezing it; no active tradition but memory in latency

- as long as scripture-based archives only, the phantasma of recording the acoustically real, i. e. the non-recordable (which has been, until the occurence of the phonograph, the human voice and musical expression) generated rhetorical, symbolic and scriptual forms of memorizing sound in imaginary ways. With the emergence of the phonograph, new type of signal recording has still been subjected to forms of inventorization and administration which were developed in the long-time context of paper-based archives

- ethnomusical recordings taken by the ethnologist Selenka in India in 1907; by over-sampled

digitizing of the original wax cylinder, possible today to listen to this play-back in exactly the same quality as the Indian natives could in 1907[564]

- irritation of the temporality of cultural memory with phonograpic recording of the real voice. Next to traditional notions of archival historicity, with recordability of oral poetry as a physical audio-event (not just symbolically like on the phonetic alphabet) kind of re-presentation of past performances takes place which remains largely invariant towards chance in historical time; media-inherent temporality differing from the established notions of cultural history

- digital processing of analogue recordings just another technical extension or does it transform the very essence of oral poetry? algorithmic processing of poetic rhythms, as genuinely re-generative, might be closer to the "formulaic" principle detected by Parry than any other kind of technical reproduction before

- notational writing (the vocal alphabet, musical notes) challenged by analog recording technologies like phonography, magnetic tape; in 21st century, symbolic notation has re-entered: alphanumeric code within computing

Transcription *versus* technical recording

- "Even Homer's rose-fingered Eos was thus a goddess transformed into a piece of chromium dioxide that was stored in the memory of the rhapsodes and could be combined with other material to create entire epics" = Kittler 1986: xxx

- cultural feed-back, when such a recording is being re-played these days to the local culture in Serbia from the sound recordings using the same device; media archaeologist in Lord's position when recording a *guslar* performance with a historic Webster Wire Recorder today

- Webster wire recorder (Webster Chicago Corporation), 1948; wire coils, tube amplifier, built-in loudspeaker; electronic (vacuum tube-based) storage medium for conserving sound, based on the transverse-magnetization of a steel wire drawn across a recording head; the device developed by Valedmar Poulsen around 1900 was originally intended for office dictation or telephone answering machine; records with 2.200 meters of wire and a speed of around 60 cm/sec., thus capable of storing up to one hour of sound. Model 80 manufactured by WEBSTER CHICAGO, in 1945, and was nicknamed an "Electronic Memory"

- mechanical sound recording directly corresponds with (and to) the mechanical vibrations of the Gusle string and the Guslari voice; magnetic recording requires the intervenence or a literally technical "medium" which is the apparatus of electro-magnetic induction; wire recorder, by its very recording medium (a steel wire), directly corresponds with the telephone line - thus allowing for a kind of direct transmission of recorded songs from storage to presence ("re-storing presence")

- around 1820, the *Darmsaite* in Manchester replaced by metal strings (for piano first); Amerikan "Idee, diese Stahlsaiten wie elektrische Impulsegeber zu behandeln" = Kittler ibid.; such *inductive* vibrations can be transduced, and upon the basis of the thermionic tubes (later

[564] See http://www.gfai.de/deutsch/projekte/bildverarbeitung-industrielle-anwendungen-projekte/spubito.html (accessed November 4th, 2013)

transistors) be amplified. Fed back into the guitar, non-linear distortions happen; Tomaszyk on *metal* string

- in media-archaeological sense reading title "the electrified Gusle" (rather a sociological reading) most literally: Tanja Zimmermann, The folk instrument *gusle* and its resistance to electrification; the metal string directly corresponds with the Wire Recorder

Rescuing the ephemerality of sonic articulation from "historical" time: symbolic notation and signal recording

- musical notation, as very time-invariant code, „saves“ (and at same time deprives) sonic signals from its temporal ephemerality: sonic articulation is ephemeral and time-based and self-annihilating by definition; Hegel: tone / transition; Isidor from Sevilla (died 630): „Nisi enim ab homine memoria teneantur soni, pereant, quia scribi non possunt“ = as quoted in Hammerstein 1966: 4 - until the arrival of Guido of Arezzos notation of musical duration (symbolically) and the phonograph (signal-really) allowed for fixing sonic articulation

- media-ontological difference between analog signal inscription (phonograph) and the electro-magnetic signal (wireless radio and magnetophonic recording) - instead of having it just as two subsequent phases in the history of technology: "Wireless embodied the core values of Tesla’s model of invention: ubiquitous transmissions, disembodied presence, and simultaneity. If the dominant paradigm of invention epitomized by Edison was one of textual remediation, time-biased inscription, and permanent representation, Tesla’s was one of oral remediation, space-biased transmission, and ephemeral presence" = Ghislain Thibault, The Automatization of Nikola Tesla: Thinking Invention in the Late Nineteenth Century, in: Configurations, Volume 21, Number 1, Winter 2013, pp. 27-52 (52); https://www.academia.edu/6320470/The_Automatization_of_Nikola_Tesla_Thinking_Invention_in_the_Late_Nineteenth_Century

- radio waves (until today's wireless LANs) "spectral" presence in a precise and metaphorical sense. Electromagnetic waves are inaudible to human ears and visible only in its small spectrum perceived as "light"; the immateriality of voice transmission by radio waves makes is a ghostly presence. Since mid-19th century the electric conductance of gas flames had been known, "and early wireless experimenters had noticed that this conductivity was affected by the presence of radio waves" = entry "Audion" to http://en.wikipedia.org, accessed February 2014

- what articulates „it“self in listening to Edison cylinders is noise such as can be expected in any transmission channel according to the theory of communication developed by Claude Shannons - a theorem which can be extended to transmission in time as well, that is: tradition. In such noise articulates itself what baroque allegories showed as the nagging „tooth of time“ - the articulation of physical entropy, the manifestation of the temporal arrow; according to the Second Law of Thermodynamics each system tends, over time, to increasing dis-order

The Wire Recorder (technical description)

- Webster Chicago Corporation, 1948: wire coils, tube amplifier, built-in loudspeaker; electronic (vacuum tube-based) storage medium for conserving sound, based on the transverse-magnetization of a steel wire drawn across a recording head; the device developed by

Valedmar Poulsen around 1900 was originally intended for office dictation or telephone answering machine. Webster wire recorder records with 2.200 meters of wire and a speed of around 60 cm/sec., thus capable of storing up to one hour of sound; entry "Webster Wire Recorder M80" in: Institut für Medienarchäologie (ed.), Zauberhafte Klangmaschinen. Von der Sprechmaschine bis zur Soundkarte, Mainz (Schott) 2008: 112

- media *un*dead: wire spool; to Garnet Hertz, Telharmonium Press, Hollywood, California: enclosed a long stripe of "recording wire" (as it was once called in the US by the Webster Wire Recorder Company, Chicago, for the Webster Wire Recorder of 1948), kind of mnemonic trace, electronic memory reduced to the thinnest possible form of electric writing (0,1mm); add it to the *Problems* like with the stripes of punched Morse code for the first edition. Just like the piece of punched Morse code might be now re-inserted into a reading mechanism which can decipher the latent massage, the piece of wire most probably magnetically stores a voice or piece of music (in fact, sound waves) once uttered around 1950 and recorded on wire, so any reader of the second edition of the *Problems* might insert it into a working wire recorder (re-activated, maybe, from a technological museum) and perceive unexpected voices; not "dead media", but: media undead; an untimeliness of media incorporated here

Technical recording vs. symbolic transcription (Bartok)

- musical transcription which Bela Bartok provided for Milman Parry's recordings of Guslari songs on aluminium disc. What the discs were able to record, though, was a surplus: the non-musical articulations, noise or bird-singing in the background, even Avdo Mededovic's coffing. Thus media-archaeology uncovers a *mémoire involontaire* of past acoustic, not intended for tradition - a noisy memory, unaccessable for alphabetic or other symbolic recording.

- different from notational transcription into musical scores, technical signal-recording of cultural articulation allows for the electro-physical measuring of recorded events (digitally done by "sampling"). This exposes the cultural event to analytic, even mathematical experimentation, thus enabling a non-hemeneutic analysis of cultural articulation on the sub-philological, even sub-alphabetic level

- *guslar* Avdo Mededovic, Parry / Lord recorded 45000 poetic lines on phonographic discs, and 33500 lines in manual transcription = Gertrud Leuze, Homer und "Oral Poetry". Milman Parrys These und meine Erfahrungen im ehemaligen Jugoslawien, in: Würzburger Jahrbücher für die Altertumswissenschaft. Neue Folge, Bd. 26 (2002), 5-12 (Anm. 8)

- with so-called digital culture, alphabetic communication returns again - no "recursion" (supposed within the same cultural algorithms) but as re-occurrence, rather re-invention, re-generation, from within the alphanumeric code, invisible to most human users of such technologies

- while Lord re-enacts some of Parry's first aluminium disc recordings with the same singers, in the meantime, technology has advanced. His wire recorder registered sound in non-mechanical ways, in the dynamics of the electromagnetic field. Electromagnetic recording and reproduction is not a continuation of writing in a new form, but a different existence of "memory". When a singer is replayed in electronic form in "high fidelity", the technology itself seems to efface itself in a way which apparently lets the originality and individuality of the singer shine through the apparatus, as dead as he might biologically be. The cultural, human aspect is being expressed in the most un-human medium; the circle of vibrations and

frequencies in technology and poetry is complete; coldest media archaeological device is the best way to memorize unique moments of human culture, such as oral poetry

Novi Pazar trip report

- appling electro-magnetic and digital filter operations, Fourier-analysis, oscillo- and sonography to recorded songs, since they have been translated in the electro-magnetic field which is waves (like sound) instead of elementary discrete symbols (the alphabet), giving access to a micro-world of technologies of culture

- Parry's apparatus disappeared long ago; designed by Lincoln Thompson, a graduate of the Worcester Polytechnic Institute and founder of the Sound Specialties Company in Waterbury, Connecticut, provided Parry with a direct cutting aluminium disc phonograph with two drives; supplied Parry with the motion picture camera used for the "Kino" because of interest in developing technologies for the sound cinema (information David Elmer, January 2007)

- Milman Parry Collection at Harvard not digitizing the original spools, but tape copies that were made in the '70s

- cultural-technological correspondence between audio-frequencies produced by the Guslari voices and Gusle strings on the one hand, and the electro-magnetic field which is induced to oscillate in the same frequencies, but finally being able to turn it into numbers (thus computing) instead of letters (both Parry and Lord neglected from a philological perspective the neuro-physiological role the accompanying use of the Gusle plays for the realtime performance of the singers - with the Gusle sound not being intended to be a musical performance of its own quality, but a sono-metrical assitance to the embodiment of the formulae)

- Lord's re-recording on Wire Recorder electro-magnetic in its full sense, not more "engraving" the voice like the grammophone but distributing sound spectra in a Faradayan "field" - a stochastic approach no more in the sense of "stoicheia" but in the sense of probabilitic mathematics (Maxwell), closer to radio (Hertz) than to writing

- subject the recordings to Fourier analysis of acoustic spectra performed by highly sensitive oscillographic and digital measing devices; switch to another mode of observation which is not fixed on the human performer any more

Computerprints for Albert Lord, MPC 1982

- "File printouts from May (?) Hyde for Albert Lord, dated 02/06/82" in Milman Parry Collection, Widener Library; archival examination by Peter McMurray; technical hardware employed by Milman Parry (phonographic recording on aluminium discs) and Albert Lord (wire recorder spools) is significant for the "analog" age, while the application of software (algorithms) for the analysis of prosodic patterns in oral poetry looks like an early example of "digital humanities" research *avant la lettre* (in every sense); Georg Danek at Vienna University; experiments in computer analysis of oral poetry (similar approach with Homeric texts); in Assembly? re-engineering

- transcription of additional notes from the computer programmer to Albert Lord; very first line:

"At long last you get some output!," written on a printout deemed a "jobfail"

- Lord/Hyde computer printout in the MPC box; identify the program code and re-engineer the automated search, against the handwritten remarks (kind of computer philology); "rhythmic" pattern woven by the printout with the spacing

- G. Danek / S. Hagel, Das Geheimnis der Lieder Homers - mit dem Computer entschlüsselt, Kremser Humanistische Blätter 3 1999, 47-55

Technologies for uncovering the correlations between oral poetic articulation and senso-motoric instrument feedback

- explicitely opposed to "notebook-orientated scholars"[565], that is: to transcription of sound into the symbolic regime of musical scores and alphabetic description, Alan Lomax used mechanic and electronic recording devices of acoustic signals to catch folk songs more precisely than any symbolic score notation can do (which has been developed to suit "harmonic" occidental music); the kinesis approach: W. Condon "first makes a detailed phonetic record of the speaker in a scence. This micro-phonetic record becomes his base line. Condon then studies the speaker's bodily behavior phone by phone, frame by frame, using a stop motion projector." = Lomax et al,: Choremetrics: 27; Denis Gabor's creation of "acoustic quanta *via* film projector

Phonography: Recording the volatile

- in cultural history, sound among the most ephemeral and transient, thus: time-critical forms of articulation, until arrival of the phonograph allowed for its reproduction at will (as expressed by Edison 1878[566]; sound loosing its temporal quality of "being-to-death". Technical recording of sound for the first time allowed to discover the time-critical essence of sound itself. While Pythagoras in ancient Greece arrived at his theory of musical harmony by subdividing a string (his monochord) by lenghts, literally kymographic media ("wave-inscribing") like Edouard Léon Scott's phonoautograph allowed to measure the same acoustic event (an octave, for example) as vibrational event, as a superimposition of fundamentals and overtones; since Edison's phonograph recorded vibrations and not symbolic scores (phyiscal acoustics instead of cosmological Pythageorean harmonics), measure of musical harmonies by length technically replaced by time as an independent critical variable = Friedrich Kittler, Gramophone - Film - Typewriter, Stanford (Stanford UP) 1999, 35 ff.

- December 2007 *Phonographic Salon* in and *as* Media Theatre (Media Studies, Humboldt Univeresity); what literary historians know, but never tested: Rilke's writing on the "Urgeräusch". Borrowing a skull from Humboldt University Hospital, application of a phonographic pick-up to listen to the zigzags of the "Kronen-Naht" (techno-like sound, indentions are rather a saw-tooth-signal); recording voices on blank Edison cylinders as well; finally test "Final Scratch" (Traktor) so reflect upon the re-entry of the vinyl groove into the

[565]Alan Lomax / Irmgard Bartenieff / Forrestine Paulay, Choreometrics. A Method for the Study of Cross-Cultural Pattern in Film, in: Ronald D. Cohen (ed.), Alan Lomax, Selected Writings 1934-1997, New York / London (Routledge) 2005, 275-284 (275)

[566] See Lisa Gitelman, Always Already New. Media, History and the Data of culture, Cambridge, Mass. (MIT Press) 2006, 25 ff.

digital disk-jockey world as an "analogue" regulating device

Inbetween the present and the immediate past: acoustic delay

- “recording the sound of my speaking voice and I am going to play it back into the room again and again until the resonant frequencies of the room reinforce themselves so that any semblance of my speech with perhaps the exception of rhythm is destroyed. What you will hear, then, are the natural resonant frequencies of the room articulated by speech" = Alvin Lucier, I am Sitting in a Room, 1969; recording himself narrating a text, playing the recording back into the room, re-recording it; new recording then played back and re-recorded; process repeated 32 times - induced by magnetic tape player (echo delay)

Phonograph *versus* magnetophone: Electronics makes a difference

- difference between analog and electro-magnetic audio recording not just a technical, but as well an epistemological one. While the phonograph belongs to what Jules-Étienne Marey once called the "graphical method" (analog registering of signals by curves), the magnetophone has been based upon the electro-magnetic field which represents a completely different type; alphabetic writing substituted by electronic recording, nowadays re-turns with digital encoding in a different quality; sampling and quantizing of acoustic signals transforms time into frequencies (by analysis as a condition for re-synthesis, in fact: between Fourier analysis and Fourier synthesis). Digitalization means a radical transformation in the ontology of the sound record - from the physical signal to a matrix (chart, list) of its numerical values; media culture turning from phonocentrism to mathematics

- phonographic record vs. magnetic record on tape; finally the digital recording represent fundamentally different materialities and logics (techo/logies) in terms of their ways of registering time-variant signals, time-based forms of reproduction and their "archival" being in time; electronic tube, especially the triode, once liberated technical media from mechanical constrains, thus: from erasure over time; still the tube or transistor are subject to decay over time themselves

- negentropic persistence against entropic time owing its ahistoricity to its different form of registering: not by signals (recording the physically real acoustic event), but by symbols

- non-invasive writing re-turning from within computing, as digital encoding

- the "acoustic real" as registered in phonography extended to the magnetic cassette tape (where the noise of the apparatus and the inscription medium - after high-frequency "sonic" pre-magnetization - is less co-present to human perception, thereby dissimulating the machinic, non-human sonic agency

- between mechanical and electro-magnetic audio recording not just a technical, but as well an epistemological difference; phonograph belonging to what Jules-Étienne Marey once called the "graphical method" (analog registering of signals by curves) and explicitely compared to a musical score, thereby integrating the graphical method in familiar cultural techniques of writing; when a record is not fixed any more on a permanent storage medium but takes places electronically; voltage replacing the stable inscription

- magnetophone based upon the electro-magnetic field which represents a completely different type of recording, in fact a true "medium". What used to be invasive writing has been substituted by electronic recording. This results in a different kind of contact zone between implicit sonicity and explicit sound

- in replay of sound recording on gramophone disc, what happens between the pick-up of the technical device and the material sound wave recording on disc is different from reading a musical score by a musician or a musicologist

- music as concept and sound vs. event (Hanslick); necessity for embodiment in order to become (e)motive: a correference between music and high-tec media in relation to their irreducible being-in-time to unfold

- mechanical records still the culturally familiar form of physical impression (writing); electro-magnetic latency a sublime, uncanny form of insivible, non-haptic memory. The voices and sounds emanating from digital audio files radically bodyless, "acousmatic" in a new, informational sense, no longer in historio-graphical time; Brian Kane, Sound Unseen. Acousmatic Sound in Theory and Practice, Oxford / New York (Oxford UP) 2014; Murray Schafer's term "schizophonia"; shock induced by phonograph: the bodyless voice

- refinement of the Phenician syllabic writing system to the Greek phonetic alphabet by adopting individual letters to express single vowels (which Ong actually called a "technologizing of the word"), acoustic articulation (speech, singing, oral poetry) symbolically recordable for real re-enactment as a kind of "phonography" not *avant* but literally *à la lettre*; still, such notation remaining a symbolic code

- Béla Bartók on the memory conditions of the phonographic recordings of oral poetry made by Milman Parry which he transcribed into a symbolic musical score: "Aluminum disks were used; this material is very durable so that one may play back the records heaven knows how often, without the slightest deterioration. <...> copies can be made in almost limitless numbers"; physical reality of such storage devices over time is the evidence that they are increasingly subject to increasing physical entropy such as the material deteriorisation of Edison cylinders or magnetic tapes. And copying as act of tradition, for analog media, is subject to a negative signal-to-noise ratio. At that point, the strenght of almost lossless symbol copying becomes evident

Technological memory: The sound of the phonograph itself

- record in the Vienna Phonograph Archive of emperor Franz Joseph I of Austria-Hungary written deep into the wax cylinder (a recording from Bad Ischl, 2nd August 1903); instead of replaying this recording for historic reference, media archaeological listening starts here: phonograph as media artefact does not only preserve the memory of cultural semantics but stores past *technical* knowledge as well, a kind of frozen media memory embodied in engineering and waiting to be listened to by media-archaeologically tuned ears, waiting to be made explicit again

- Austrian emperor Franz Joseph's actual statement. Significantly, this statement - one of the first voice recordings preserved at all - tuns out to be the pure message of the medium. When a new technical medium emerges humans are very aware of its technicality (which afterwards, when it becomes mass media, tends to be forgotten in favor of so-called "content"). The

emperor expresses his joy to literally "incorporate" his voice into the Vienna phonograph archive: "Es hat mit sehr gefreut, auf Wunsch der Akademie der Wissenschaften meine Stimme in den Apparat hineinzusprechen und dieselbe dadurch der Sammlung einzuverleiben." Indeed possible, today, to listen to human voices which exterminated hundred years ago, by applying laser reading of the wax cylinders which do not destroy its source in the act of re-play - message (the emperor) or noise (the scratch)?

- *paraisthesis* the noise of the wax cylinder itself which the record articulates whenever it is being re-played is not discursive (cultural) but media-archaeological information of the physically real event; not exclude it hermeutically like in the proverbial Cocktail party effect of auditory communication between humans; with the micro-physical *close reading* of sound, the materiality of the recording medium itself becomes archivally poetical.[567] Instead of musicological hermeneutics the media-archaeological ear listens to signals; power of signal-based technical media in their ability to actively (re-)create real presence; an unvolontary memory, thus: the memory of the real sonosphere which inadvertedly inscribes itself into the record: "There are many 'conversations' in addition to the songs incorporated in the recording, talks between collector and singer concerning data connected with the song [...]. It gives you a thrilling impression of liveliness, of life itself." = Bartok ibid.

Lord's Wire Recorder

- "The singer sings and the scribe records, whether on aluminum wire or discs or by means of graphemes on a flexible substance. <...> / There is no audience to entertain, except the recorder <...>, the recording of the poem is doing something to the shape of the poem" = Powell 2002: 6 f.; neither Parry nor Lord "interested in the nature or history of the technology that had made the text of Homer possible, any / more than Parry investigated the history of the recording machine" = Powell 2002: 7 f.

- Albert Lord "discovered a new way to make a text. He carried to Yugoslavia the best electronic recording equipment he could find, when <...> some songs were taken down on aluminum wire, others on metal discs. In the Milman Parry Collection at Harvard, Albert Lord showed <...> several rolls of this wire, hopelessly tangled in a drawer - what lost songs does this tagled text preserve? Aluminium wire <...> is not oral song, but a kind of text <...>. Parry ´s aluminum discs and wire, just as much as a papyrus with graphemes scratched thereon, provide a material basis - obviously liable to corruption - for a code impressed upon it. In either case the text depends on technological innovation: the Greek alphabet <...>, inscribed on parchment or papyrus, and electronic magnetization <...>. All texts are useless without the technology to decode its symbols: the rules of Greek alphabetic writing <...>, a tape-player <...>" = Barry B. Powell, Writing and the Origins of Greek Literautre, Cambridge u. a. (Cambridge UP) 2002, 6

- ultimate challenge to the vocal alphabet which could never actually write down the sound of breaking waves which can only be recorded by electro-magnetic media

Retextualizing audio(visual) records: Digitized sound

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[567] Karl Sierek, Die weiße Leinwand, in: ders., Aus der Bildhaft. Filmanalyse als Kinoästhetik, Wien (Sonderzuahl) 1993, 115-130 (122), referring to: Umberto Eco, Semiotik, 263 f.

- active media archaeology, opto-digital reading of otherwise unaccessible sound recording, retrieving past sound signals by digital sampling and quantification; what appears to the ear like the restituted sound, in fact the function of a techno-mathematical matrix / filter

- Florens Chladni experimenting with acoustic wave figures in sand created by the vibrations of the violin bow; visualisation as opposed to mathematical analysis

- "Spektrogramm einer rekonstruierten Tonaufnahme (Wedda-Gesang, Ceylon 1907)" in: Stanke / Kessler, xxx; digital *close reading* of sound dissolves any signal into discrete blocks; textual regime returns (in alphanumeric codes)

- "[H]istory, in its traditional form, undertook to <...> lend speech to those traces which, in themselves, are / often not verbal, or which say in silence something other than what they actually say" = Michel Foucault, Archaeology of Knowledge, transl. A. M. Sheridan Smith [*1972], London / New York (Routledge Classics) 2002, "Introduction", 3-19 (7); relation between performative ("textual" or audiovisual) surfaces to what is being operatively processed on the other side of the coin, within the Central Processing Unit of microprocessors

- algorithmic archaeology the return of "textuality" in the representation of the past, but this time text itself becomes media-active - kind of operativity which the handwritten or printed text never knew. Digitized signals at first sight resemble the tradition of music notation; they wait to be algorithmically executed

- early application of phonography for philological research, a recording of the oral poet Avdo Medjedovich in former Yuguslavia by Milman Parry and Albert Lord around 1935: Milman Parry Collection of Oral Literature, Harvard University. In listening to such a sound *online*, the ear tends to be trapped by the referential illusion, believing that it is confronted with the audio signal; in fact, discrete bit-strings are being processed - sublime textuality, operating on the subliminal level of human understanding; Leibniz, "nesciens" - mathematically calculating perception of breaking waves; even with infinite approximation an algebraic *calculus* will never equal the physical world. "Womöglich sind Wolken keine Computer, die jeden Regentropfen berechnen, und umgekehrt Computer keine Maschinen, die Wolken das Regnen abnehmen" = Friedrich Kittler, Ein Tigertier, das Zeichen setzte. Gottfried Wilhelm Leibniz zum 350. Geburtstag, in: *mtg* (Medien/Theorie/Geschichte) Nr. 3 des DFG-Projektverbunds *Theorie und Geschichte der Medien* (1996); http://www.uni-kassel.de/wz2/mtg/archiv/kittler.html;
how textuality becomes powerful beyond humans, within technomathematical machines

Re-discovering the sound of "texts": Oral poetry

- misunderstandig with the notion of "Oral Literature" (nomination of the Parry Collection at Harvard University); nothing "literal" in oral poetry, no letters, no alphabet, no recording; message of the medium is neuro-temporal (realtime poetics), not spatially literal

- escalation between the alphabetic "techno*log*izing" of the spoken word (Walter Ong) and mechanic and electronic signal-recording of "oral poetry" (Milman Parry / Albert Lord in former South-Yugoslavean *guslari* culture); finally, creative algorithms mobilizing the digitzed voices for a different kind of insight; still, the techno-traumatic event of the dis-embodied voice and the means its spectrographic analysis haunt cultural memory, since they remind of the technicity of sound within the human itself (like "thinking", with Turing / Lacan) = media-

theoretical turn-around (*Kehre*)

- "historical" musical instrument actually has to be played in order not to decay physically - which in case of techno-historical electronics means replacing some active or passive electronic elements (case of the archaic electro-acoustic instrument *Subharchord* in the archive of the Academy of the Arts, Berlin); what is strictly forbidden in traditional archives: to interfere with the original "record"; re-enactment (signal processing) the essence of musical and technical objects; the *archive in motion* its only way of existence: active material philology

- in media-archaeological terms, the very fact that the *gusle* has been recorded on aluminium discs (Parry) and magnetic wire (Lord) reveals the isomorphy between electronics (oscillators, resonance circuit) and vibrational events in human / instrumental culture

- technically induced media-archaeological *Kehre* with phonograph recording; „secondary orality“ (Walter Ong) or "derived" (Foley 1990) revealing the phono-graphic (vibrational rather than phonetic-alphabetically discreet) nature of human "orality" itself

Speech becoming "immortal"

- only media able to register physically real signals can deal with time-based events like sonic articulation and movement

- technical media as archaeologists of sound: re-gaining acoustic information by laser-optical scanning from Galvano copper negatives

- "Speech", as it were, has become immortal", Thomas Alva Edison announces in *Scientific American* of 1877 immediately after *finding* of phonographic signal recording = as quoted in Kittler 1986: 37

- media-phenomenological fallacy; the technical "undead" in signal recording media; interlacing of temporalities between (*a*)*live* and *recorded on tape*: "That is perhaps most uncanny when you hear a program about someone who is dead, and that person´s voice is broadcast and is as `real´ sensorially, as `present´ [...]" = Weber 1996: 160

- listening to human voices which exterminated hundred years ago, by applying laser reading of the wax cylinders which do not destroy its source in the act of replay. But what we hear is not simply the vocal message but the noise (the scratch) of the wax cylinder itself - which is no coded content from cultural history, but media archaeological information, an articulation of the techno-real itself; task of media studies to open the ears for such understanding

- micro-physical *close reading* of sound, where the materiality of the recording medium itself becomes poetical[568], dissolving any semantically meaningful archival unit into discrete blocks of signals

Trans-cultural musical memory? A techno-cultural paradox driven by traumatic

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[568] Karl Sierek, Die weiße Leinwand, in: ders., Aus der Bildhaft. Filmanalyse als Kinoästhetik, Wien (Sonderzuahl) 1993, 115-130 (122), referring to: Umberto Eco, Semiotik, 263f

"future in the past"

- epistemic trauma rootet in the technological shock (since Edison's phonograph) and the "deadly" ambivalences of recording "live" itself; effects and affects of re-presencing the past by media memory; viewer / listener co-affected or even "co-traumatized" (Jan-Claas van Treeck); stems from the technological setting itself which continuously challenges and irritates the human sense of presence

- recording projects in ethno-musicology a technological function of traumatic anxiety about the disappearance of indigenous cultures, resulting in techno-archiving practices in the temporal mode of "future in the past"

- like the phonographic archives established in Vienna and in Berlin around 1900, the photographic expeditions undertaken by Albert Kahn for his *Archives de la Planéte* in the 1930 and further projects, Bowles' Marroccean folk song recordings driven by a kind of anticipatory trauma that the indigene culture he referred to was about to be extinguished; never listened himself to the tapes he feverishly recorded; almost forgotten they time-invariantly rested in magnetic (rather than cultural) latency until they were discovered for re-play

- not "collective memory" but a collection of recordings in technical storage - meant as memory of an anticipated *futurum exactum*, driven by a virtual trauma; reverse: the current "Retromania" (Simon Reynolds) in popular music which compensates for the absence of utopean or avantgardist perspectives in current musical culture - a thought expressed by Jan Rohlf for the 2014 theme of CTM - Festival for Adventurous Music and Art "DIS CONTINUITY", Berlin (January / February, 2014)

- "archival potential" of phonographic recordings coinciding with moment "when many indigenous cultures were already severely threatened, or had already disappeared, ironically as a result of the same Western industrialization that produces the technology used for the documentation. [...] the fact remains that the technology provided a literal documentation that surpassed the results of even the most sensitive transcriber. <...> many ethnomusicologists were so conditioned by Western muscial practice that they interpreted what they heard and transcibred it according to Western musical notation, ignoring the microtonal variations that can still be heard on original recordings. Therefore, such objective documentation can be said <...> to preserve the aural artifacts of a culture" =Barry Truax, Acoustic Communication, Norwood, N. J. (Ablex) 1984, 118 - its sonic *aura*. The technical recording (that is, the media-archaeological ear) preserves acoustic signals which might have already been obscured by symbolically coded cultural memory. Even if "[t]here is no guarantee that one can ever bridge the gaps between cultures" - and temporal distance between sonic articulations -, "the perspective of time and familiarity can certainly clear a way some of the veils that obscure a culture from us" = Truax ibid. - revealing the sonicity of the cultural unconscious.

- even with his copies of all the tapes he sent to Washington, Bowles never listening to one of them again. The issue was conservation (German "Tonkonserve"), materially canning the acoustic event, for a (principally) infinitive time interval. A different kind of *non-living* memory is at work here, in both cultural and magnetic *latency*; when no alternating but direct current in some of the local villages, no recording took place at all with the AMPEX magnetophone equipment

- anticipatory technological recording while the culture itself is still intact; escalating in ballistic World War II anti-aircraft prediction. In order for the artillery to fire is bullets "just in time", the

data of the approaching enemy aircraft had to be recorded and calclated in real time to anticipate its future position. This corresponds with the temporal grammar of *futurum exactum*, the "future in the past" - that which will have been. History not in the past any more but anticipated in a projected future

- techno-cultural *dissonance* rooting in the fact that the very audio-visual "new media" of documentation were part of the same modernization and industrialization which is responsible for the destruction of more traditional ethnic cultures constituting the object of recording

- Albrecht Meydenbauers German Monument Archive (das Deutsche Denkmälerarchiv), based around 1900 on photogrammetric measuring of historic architectural heritage, anticipated future destruction of the originals caused by possible wars already; pre-emptive media archive embodies the time-reversed trauma, known from grammar as "future in the past" *(futurum* exactum); from the technological condition of photography, cinematography and phonography itself that the traumatic *futurum exactum* as a kind of reverse non-historical trauma arose: the concept that a cultural articulation might *possibly* be extinguished and thus in anticipatory ways needs technical pre-recording

Disembodied voices from analog to digital analytics

- *cultural analytics* (algorithmic analysis as defined by Lev Manovich) un-ethical when it comes to traumatic testimony like audio and video recordings of Holocaust survivors? Todd Presner, The Ethics of the Algorithm: Close and Distant Listening to the Shoah Foundation Visual History Archive, typeskript (conference paper draft, March 2012, http://www.toddpresner.com/wp-content/uploads/2012/09/Presner_Ethics.pdf

- as signal communicated *via* air pressure, sound is material, even violent; but as a temporal form it is volatile and perceived as "immaterial" phenomenon; Derrida's sensation of the *anima* in voice recording: "I am always overwhelmed when I hear the voice of someone who is dead, as I am not when I see a photograph or an image of the dead person"[569] - in spite of the Barthean *punctum*. "I can be touched, *presently*, by the recorded speech of someone who is dead. I can, *here and now*, be affected by a voice beyond the grave"[570]; according to an hypothesis developed by John Durham Peters, this double *media* only takes place with analogue media and abruptly ends with digital data processing; in signal recording, *in*distinction between message and noise, referential recording and the articulation of the recording device itself - while binary data - though technically still being embodied in electrophysics and driven by current energy - *per definitionem* in communication theory abstract from the material implementation

- recording of the acoustically or optically "real" physical signal opposed to symbolic notation by the alphabet not only in a technical but also in an epistemological way: the difference between physical signal as indexical and the arbitrary cultural symbol. With computing, though, this dialectic opposition becomes synthesized, since Digital Signal Processing (notably sampling of audio events) is a function of discrete symbolization, a re-entry of the "alphabet" in

[569] Jacques Derrida, Above all, no journalism, in: H. de Vries / Samuel Weber (eds), Religion and Media, Stanford, CA (Stanford University Press) 2001, 56-94 (71). See Paddy Scannell, Television and the Meaning of Life, Cambridge (Polity) 2014, 126

[570] Derrida 2001: 71

numerical and logical form. If according to Walter Ong the electronic revolution in mass media communication devices like radio and television has led to a "secondary orality", communication based on the symbolic machine (computing) has led to a (hidden) secondary alphabetic revolution, with bits and bytes inheriting the typeset, but different from the printing culture in a dynamic way. The voice turns silent and still articulates - in implicity mathematical sonicity which is the ultimate shock to occidental logocentrism.

Singers and Tales in the 21st Century: digital memory

- with digitization, a dramatic change of memory records; "big data" of past recordings generated and "social" memory transformed into computability; not just a further escalation of the pick-up / record groove constellation, but in fact an epistemological *transsubstantiation*.

- human epic performance, once being recorded, becomes post-memorial and technical storage instead. The carrier of the cultural information is not a human signal (voice and gesture) but magnetic tape. With digital computing, an even more dramatic change takes place which transcends the analog transduction of epic songs; the same kind of steel wire which has been the basis for Albert Lord's magnetic recordings in former Yugoslavia in 1950, all of the sudden, becomes a grid generating the Cartesian matrix texture of an electronic computer memory device, so-called Magnetic Core. Ironically, this digital memory hardware has become the media-archaeological condition for a "social memory" of a second order such as the "Community Memory" project, a telephone-line, Modem- and computer-based social network which emerged around 1970s in the San Francisco area, figuring centrally a Time-Sharing main frame computer (the SDS 940). What has been "collective memory" in sociological terms has become cold storage, and the use of the term "memory" for both implementations (human bodies and minds vs. hardware) is rather misleading.[571] As RAM the SDS 940 consisted of magnetic core memory units; its very image internally mirrors the social "net-work" literally = Höltgen 2014: 397 f.; Höltgen 2014: 398, Fig. 5. This is truly and non-metaphorically called "social memory 2.0", since memory here is a direct function of the capacities and limits of the computer data storage.

- digitization of the audiovisual legacy of Parry and Lord on aluminium discs and wire spools in difference to the essence of its cultural content; Plato's primary „media“ critique of writing as an ambivalent memory technology valid again

Motion and immobilization: the audiovisual archive

- in media-archaeological awareness, a phonographic recording primarily memorizes the noise of the wax cylinder itself - which is different kind of "archive", not cultural-historically, but cultural-technologically, a different kind of information on the real. Media archaeology opens ears to listen to this as well, not to filter this out.

- phonograph as media artefact not only carrying cultural semantic like words and music, but -

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[571] See Stefan Höltgen, "All Watched Over by Machines of Loving Grace". Öffentliche Erinnerungen, demokratische Informationen und restriktive Technologien am Beispiel der "Community Memory", in: Ramón Reichert (ed.), Big Data. Analysen zum digitalen Wandel von Wissen, Macht und Ökonomie, Bielefeld (transcript) 2014, 385-403 (386)

like any work of art - at the same time an archive of cultural engineering as well, by its very material fabrication - a kind of frozen media knowledge, which - media-archaeologically - waits to be de-frozen, liquified

- different (media-)archival tempor(e)alities: As opposed to an "archival" transcription of, for example, oral poetry by alphabetic or musical notation, its recording by phonograph or gramophone creates a presence in latency, a different temporality, since these sources can be re-played with equal originality (*gleichursprünglich*): Repetition with difference on the macro-temporal time axis, but identical reproduction of its inherent temporal event, invariant towards "history". Bela Bartok once transcribed Yugoslav folk music of gramophone recordings (both from aluminium disc or later from electromagnetic wire recorder) in the Milman Parry Collection at Harvard University (Cambridge, Mass.)[572] , thereby translating the physically real articulation into the symbolical regime which increases "information" in terms of order and selection, but looses additional information like the individual intonation, the temporal subtilities and the accidents, the "noise" as the authential trace of the unique performance event; with technical reproducibility of movement and sound, cultural memory liberated from restrictions to symbolical notation which leaves us with a bifurcated memory: the symbolical and the real

- as long as there is still a player, the recordings themselves can be originally be replayed and re-transcribed in completely new, variable ways. The acoustic event can be measured by oscillographical visualisation or spectral analysis; even a singer's caughing thereby is subject to techno-mathematical, non-cultural analysis

- first uses of sound film for musicological documentation "Avdo movie", Milman Parry Collection website. At 1:20 min. the sound recording abruptly ends in the middle of a verse line ("Ni bih ..." / "Nor would I ..."), while the sound of the rotating disc takes over rythmically: Now the medium speaks; a few seconds later (1:37), the kinematographic recording breaks down as well. With that rupture, the real of the medium is at work, and physically breaks into the symbolic cultural scene. Watching such a record, an anthopological mis-reading happens: We tend to forget about the recording apparatus and concentrate on the body and voice of the singer, looking at him as if he was still alive, being touched by his performance which is in fact nothing but a technological re-play. Thus let me contrast this emotional audiovisual record by showing such a recording as a technological event

- constant reminder that there is no human voice but a machinic voice, in the sense of the transduction of body-based voices into a electronically reprocessed voice. The frequencies, even the timbre of the voice, miracolously, is still the same in both "media"

- Albert Lord on the recording of Yugoslav guslari: Unintentionally, the recording turns improvised oral poetry into a fixed text like the jazz improvisation recorded and electronically mastered provided for a immutable reference version and photography freezes a moment of live into a still. "Proteus war photographiert worden [und] an dieser Aufnahme wurde hinfort jede Veränderung gemessen - sie wurde zum "Original". Albert B. Lord, Der Sänger erzählt. Wie ein Epos entsteht, München (Hanser) 1965, 185; AO: The Singer of Tales

- electromagnetic recording preserving unique feature of the oral performance (different from its alphabetic, immobilizing transcription) which can be derived from how French language calls the recording device: *écriture magnétique*. Electromagnetic recording, by its very physical

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[572] Bela Bartok, Parry Collection of Yugoslav Folk Music, New York (New York Times) 1942

immateriality, only comes into existence as part of a dynamical process, the *inductive* act of re-play ("writing" different from "printing"). In his preface to Albert B. Lord's *The Singer of Tales* Harry Levin remarks: "The Word as spoken or sung, together with a visual image of the speaker or singer, has meanwhile been regaining its hold through electrical engineering."[573]

- technology within two temporal forms of existence; hardware (*techné*) is subject to entropy; the symbolic code (*logos*) survives

- With the necessity of digitizing phonographic records in order to preserve them against physical, media-archaeological entropy, a new epistemological option emerges which demands media-theoretical attention - as expressed in the presentation of the SpuBito project of www.gfai.de: "The retrieved sound documents can directly be stored on digital media (e. g. CDs) for archiving or processing" - the "archive in motion" indeed

- media-archaeological retrieval of "lost sound" a delicate detour for the human and technical senses / sensors: Obsolete sound recordings, as distorted signals, are first transformed into spectral images by optical scanning, before being algorithmically processed into sound (or noise, in the barely recognizable case of the "first" Norwegean phonograph recording supposed to be a Biblical psalm). Here, "imagenesis" (Jon-Inge Faldalen) is part or the inner-technical procedure, with the ephemeral function of the image (imaging) being exhausted in generating sound;
https://www.nrk.no/kultur/xl/kan-verdens-eldste-opptak-av-edison-ha-ligget-i-en-norsk-kjeller-siden-krigen_-1.13727285; accessed November 13, 2017

- algorithmically driven ("automated") tagging (mark-ups); set of metadata gained from *within* the auditive signal event reveals its inherent spatial geometry and temporality. Such digital archaeonautics is the opposite but may be combined with "social tagging" in Open Access Web 2.0 circulation which is non-classified in similar ways: a hybridisation of order and random access, of techno-logical and "collective" memory.

- not historians but software as archaeologist which listens to audio(visual) recordings from the past in the method of sonic analytics applying linguistic software such as Praat; on the linguistic field that the first computational algorithms for voice recognition have been developed

- Folke Müller, Die Tonhöhe historischer Filmstimmen als soziolinguistische Variable, in: Zakharine / Meise (eds) 2010: 233-247

Reverberative memory

- towards a non-anthropocentric and technomathematical theory of cultral transmission

- Milman Parry's and Albert Lord's phonographical and electronic recording of the oral poetry of the southern Yugoslavian guslari culture in the 1930s; yet they accessed this culture through transcriptions that focused on words only: philology neglecting the vocal micro-timings and the one-stringed Gusle instrument that was integral to the performance. Reverberative memory can only preserved by signal recording. The sonicist relation between present and past is

[573] Boston (Harvard University Press) 1960, xiii

based on resonance: a non-historicist figure of time that is itself temporal in its articulation. Sonicity, with its time-critical qualities, is here a metonym for the temporality of the world as event; perspective further underscored by the mnemo-generic capacities of recorded sound and in particular digitized sonic materials that are susceptible to the operative memory of algorithmic procedures

- Sóonia Matos on the archival potentials of a purely sonic language
in danger of extinction, the whistle language known as Silbo Gomero
that is still partly in use on the La Gomera island, in: Ina Blom et al. (eds.), Memory in Motion, AUP, 2017; language composed of sounds that have no relation to alphabetic transcription; its articulation is also much a function of the spatial context (echo and reverb). Linear transcription and storing of linguistic units fails to convey the actual functioning of the language in acoustic space; discard traditional ideas of archival preservation that usually support the protection of endangered languages

Locating the Sirens

- wax cylinder an essential recording medium; according to Descartes and Fritz Heider, it provides a loose coupling of elements, on which a tight sonic coupling ("form") can be phonograpically impressed - in/formation

- In 1925, Sigmund Freud's *A Note upon the `Mystic Writing Pad´* in which he compared human memory apparatus with a common children´s toy. One makes incisions onto a way tablet, over which has been stretched a thin sheet of cellophane; cp. acoustic membrane/ microphone. When one pulls up the cellophane, the marks on the surcace seem to disappear. "Yet the traces of the incisions remain in the wax, almost unreadable, yet present all the same" = paraphrased in: Arnold Dreyblatt, Inscriptions, 2005 Frankfurt /M., 32. Original: "If we lift the entire covering sheet <...> off the wax slab, the writing vanishes and <...> does not re-appear again. The surface of the Mystic Pad is clear of writing and once more capable of reveiving impreessions. But it is easy to discover that the permanent trace of what was written is retained upon the wax slab itself and is legible in suitable lights. But htis is precisely the way in which <...> our mental apparatus performs its perceptual function." = Sigmund Freud, A Note upon the `Mystic Writin gPad´, in: International Journal Psycho-Analysis, 21 (4), 469-74, trans. James Strachey 1950

- Heckl's design for archaeo-acoustic experiment: re-play of grooves from ancient pottery, and Gergory Benford's Science Fiction novel *Time Shards*

- Platonic dialogue *Theaetet* (§ 191), where Platon lets Socrates say: "Please assume <...> that there is in our souls a block of wax <...>. this is the gift of Memory, the mother of the Muses, and <...> whenever we wish to remember anything we see or hear <!> or think of in our own minds, we hold this wax under the perceptions and thoughts and imprint them upon it, just as we make impressions from seal reings; <...> but whatever is rubbe dout or cannot be imprinted we forget and do not know."

- "[...] parce que les Sirènes qui n'étaient que des bêtes [...] pouvaient chanter comme chantent les hommes, elles rendaient le chant si insolite qu'elles faisaient naître en celui qui l'entendait le soupçon de 'inhumanitè de tout chant humain" = Maurice Blanchot, Le live à venir, chap. I "Le chant des Sirènes", section "La Rencontre de l'Imaginaire", 9-18 (10); Blanchot taking into account the notion of human singing turned upside down: "Some have

said that is was an inhuman song - a natural sound [...] but on the borderline of nature, at any rate foreign to man; almost inaudible [...]. Others suggested that it [...] simply imitated the song of a normal human being, but since the Sirens, even if they sang like human beings, were only beasts [...], their song was so unearthly that it forced those who heard it to realise the inhumanness of all human singing."[574]

- Barbara Engh, referring to Theodor W. Adorno's writings on phonographic recording, accentuatng the extent to which the Sirenic singing is not human; "wherein the more perfectly the machine is able to represent the human, the more thoroughly is the human removed [...]"[575] - or, rather, discovered; techno-traumatic element of the voice itself as "the site at which, in the distinction between the cry and the song, the human and the inhuman are differentiated in a state of perennial irresolution."[576]

- a "grey zone between natural sounds and specifically addressed messages with a human quality. "Meaning emerges from noise and reinforces its content by activating a cultural memory of antiquity - a Lacanian transfer from the real (waves) over the symbolic (encoded communication) to the imaginary [...]."[577]

- (a)historic dilemma: How can an acoustic event which is supposed to have happened before the age of gramophonic recording be verified? Testng and reconstructing such acoustic events by media-archaeological means is a sound analytical provocation to classic philology.

- Sirens "non-human" in terms of machinic or cyborg sound. What makes the mythologic Siren motive relevant for present media archaeology of sound is the intervention of the phonograph, since for the first time, the replay of recorded voices was considered like the presence of humans while at the same time knowing it is reproduced from dead signals on a storage medium - and even more with electronic sound processing; mythic Sirens address the non-human side of technical media; the fact that technical media are media of non-solid, non-phenomenologial worlds (electro-magnetic fields, high-level mathematics, speeds beyond human comprehension"[578] - which, beyond the phonograph, is true for electronic sound media up to the digital sound processing of today with "ultra-sonic" speed of processing

- vocal effects of presence nowadays achieved by completely computational artefacts. Uncanniness derives from the technological Turing test.

- Since the nineteenth-century, Sirens became a term for a technical vowel sound generator, i.

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[574] Maurice Blanchot, The Sirens's Song. Selected Essays, Bloomington (Indiana University Press) 1982, 59-65 (59)

[575] Barbara Engh, Adorno and the Sirens: tele-phonographic bodies, in: Leslie C. Dunn / Nancy A. Jones (eds.), Embodied voices. Representing female vocality in western culture, Cambridge et al. (Cambridge University Press) 1994, 120-135 (126). See as well Thomas Y. Levin,For the Record: Adorno on Music in the Age of its Technological Reproducibility, in: October 55 (Winter 1990), 23-47

[576] Engh 1994: 134

[577] Winthrop-Young, Siren recursions, in: xxx

[578] See the chapter: Non-human media, in: Jussi Parikka, What is Media Archaeology?, Cambridge / Cambridge, Mass. (Polity Press) 2012, 55-61 (62)

e. a signalling device, "subsequently playing a key part in the mapping of the thresholds of hearing [...]."[579] This inverse re-occurrence of the mythic Sirens, though, is not within cultural history, but in a coupling of human cultural time and a non-human evidence; fig.: Vocal Siren, from: Hermann von Helmholtz, Ueber die physiologischen Ursachen der musikalischen Harmonie (lecture 1857), in: Vorträge und Reden von Hermann von Helmholtz, vol. 1, 5th edition, Braunschweig (Vieweg) 1903, 119-155, Fig. 1

- the agency of sound-archaeological research is the technical siren apparatus indeed to synthesise vowels - especially in the double siren version as developed by Hermann von Helmholtz, remarkably corresponding with the *casus dualis* of the Homeric Sirens; explicit harmonic analysis of acoustic vibrations (in adoption of Fourier's mathematical analysis) for the sensation of hearing "tones" achieved by G. S. Ohm, Ueber die Definition des Tones, nebst daran geknüpfter Theorie der Sirene und ähnlicher tonbildender Vorrichtungen, in: Annalen der Physik und Chemie, vol. 59 (1843), 513-565

- With the technical siren as *sonic* device (developed by Cagniard de Latour and refined by Hermann von Helmholtz) the vocal formants became mathematically analysable and thus calculable, with a retro-effect towards the metaphysics of the voice in occidental ontology: Since then, a human voice is considered and perceived as a frequency-based vibration event in itself, no less "mechanical" than technical machin communication and recording like telephony and the phonograph. When the technical siren as acoustic pulse generator confronts its mythological other, the Homeric Sirens, the myth itself fails and dissolves into a knowledge-driven material and dynamic construction of a signal event which is not controlled but simply modulated by humans; not invented, just dis-covered in culture. Geoffrey Winthrop-Young points out the special twist of this forensic Siren analysis: "[...] one of the sound-producing devices used to disconceal the ancient Sirens was an aerophone, a noisemaker that produces signs by interrupting the air flow—in other words, a modern siren. Sirens track Sirens" - which is both acoustic media archaeology and media archaeology of the acoustic.

- S/sirens: typographic slash both folds and breaks cultural discourse and techno-logical implementation. Against the suggestions of the historic timeline, "[r]ecursions fold time and thus enable direct contact between points and events (and S/sirens) that are separated when history time is stretched out on a continuous line."[580] Such a procedure was carried out on a technical level: sound-producing technologies were used to project sounds to and from the Li Galli islets while being recorded by storage devices. The subsequent technical analysis of the recordings produced an truly techno-logical insight: "Sounds emanating from the main island Gallo Lungo hit the Siren rocks Castelluccio and La Rotonda and, much like a ball caught between the flappers of a pinball machine, start to echo between the two, resulting in the disorienting sonic phenomenon experienced by Bradford [...]"[581], while even more addressing ears which are *turned* by the archaic Greek theory of musical sound ratios closer to Pan's *double* flute *(auloi*) than to the classic Apollinic lyra; only from the closest techno-archaeological analysis new cultural insights arise once coupled with aesthetic knowledge. For further *acoustic reasoning* on the site, there is still latent sonicity waiting to be unfolded

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[579] Parikka 2012, 67, quoting John Armitage, From Discourse Networks to Cultural Mathematics. An Interview with Friedrich A. Kittler, in: Theory, Culture & Society vol. 23, no. 7/8 (2006), 17-38 (33)

[580] Winthrop-Young, op. cit., note 5

[581] Winthrop-Young, op. cit.

media-archaeologically[582]

- In terms of cultural techniques, the condition for such an awareness was the phonetic alphabet[583]; the mythological Sirens are a (auto-)poietic function of phono-graphy *avant la lettre*; ancient Greek notational practice of the vowel alphabet in use both for musical and for speech notation set an epistemological *a priori*. From the point of view of the archaeology of knowledge, this kind of vocal analysis does not contain its *telos* in the phonograph, spectrogram and Vocoder but remains within the regime of the symbolic (thus "cultural") order. It is the radical break with the phonetic alphabet, a paradigmatic shift / replacement by a truly media-technological, indexical relationship to the sound of the voice, that the phonograph resulted - with the allegorical design as "Siren" or "Loreley" just being a mythological re-call

- Walter Benjamin in section XIV of his essay on *The Work of Art in the Age of Mechanical Reproduction*; there are "critical epochs in which a certain art form aspires to effects which could be fully obtained only with a changed technical standard"[584]. This happens on the level of the symbolic signifiers as well. The alphabetic vowels transposed Homer's voice into symbolic recording, while the technical siren generates tones by numbered holes representing numerical frequencies as the reverse of the time domain of wave forms.

- "The phonograph is [...] incapable of achieving real-time frequency shifts. For this we need rock bands with harmonizers that are able to reverse - with considerable electronic effort - the inevitable speed changes, at least to deceivable human ears. Only then then [...] women can be men and men can be woman again."[585]

- epistmological rupture between "analogue" and "digital" electronics, incorporated in a literally transitional device: the analog-to-digital converter ("Sampling"). A voice transposer who does not simply want to produce the Mickey-mouse effect (by speeding up tape recordings of a voice) must contain a mirco-processor (which in Kittler's case had been programmed in Assembly language); electronic Harmonizer in acoustic synthesizing transposing male into female voice *vice versa*; Springer Tempophon time-stretching allows to transpose audio without changing it's length, similar to Variphrase technology from Roland; info in German on: sequencer.de; cp. Gabor's cinematographical quantizing sound

- to arrive at "non-Pythagorean sound"[586], it required a media-technical archaeology of listening, by focusing on the non-human means of observation, measuring and recording as active agencies of knowledge on hearing; the loudspeaker as sonifyer plays a crucial role. It was with the invention of the electric telephone and the vacuum tube-based, thus amplifying loudspeaker that prevously non-acoustic phenomena (such as small electric currents in human

[582] See Martin Carlé, Enharmonische Archäologie der griechischen Musiknotation, in: W. E. / Friedrich Kittler (eds.), Die Geburt des Vokalalphabets aus dem Geist der Poesie, Munich (Fink) 2006, 281-297

[583] See Walter Ong, The Technologizing of the Word, London 1982

[584] Walter Benjamin, Illuminations. Essays and Reflection, ed. by Hannah Arendt, New York (Schocken) 1968, 237

[585] Friedrich Kittler, Gramophone - Film - Typewriter, Stanford (Stanford UP) 1999, as quoted here in: Jonathan Sterne (ed.), Sound studies reader, London (routledge) 2012, 243

[586] A term coined by Johannes Kroier, Berlin

nerves) could be sonified in physiology and other branches of science; so-called "cultures of listening" and techniques of sonification which have emerged within cultural studies in recent years is itself such a media-technological effect. In previous centuries, sonic articulation has belonged to the most *transitive* cultural phenomena; hidden acoustic knowledge has not rarely been existent to cultural consciousness though it was co-present in any articulation

- *listening* to to (past) sono-spheres; the World Soundscape Project of Raymond Murray Schaffer and other projects to "archivize" soundscapes

- historicist re-enactment of music from the past: When instruments from the past are not just objects in historical museum but re-used to perform ancient music, they change their essence from historical to processual hardware, thus: truly becoming media (again); they transform from historical to media-archaeological objects; embody the physics of past soundscapes

- trying to re-access transient articulations, past modes of listening - which vary with cultural history - can not only be reconstructed by written descriptions; both past and present ears can rather be coupled to the same media mechanisms - be it the Pythagorean monochord, be it the Edison phonograph; acoustic or musical experience which depends on electronic devices is appropriately calld *sonics*. Such technically embedded logics, exactly because it is non-human itself, allows for a non-historical immediacy, a co-original (German: *gleichursprüngliche*) situation. The media archaeologic assumption is that the human auditory apparatus is forced to obey laws imposed by the media apparatus itself; historicity therefore is deferred by and to such technologies

- (pre-)Edison sound(s) not to be historicized at all, since they do not exist as historical but diagrammatic records = Axel Volmar, Gespitzte Ohren. Akroamatische Dispositive und musisches Wissen als Grundlage für eine Geschichte epistemogener Klänge, in: MusikTheorie. Zeitschrift für Musikwissenschaft, vol. 22 (2007), no 4 (thematic issue: Perì mousikès epistéme. Zur Aktualität des antiken griechischen Wissens von der Musik, edited by Sebastian Klotz), 365-376 (366); best method to understand a medium is by re-engineering it and by its functional (re-)enactment: on "reenactment" as historical method: R. G. Collingwood, The Idea of History [*1946], rev. ed. Oxford et al. (Oxford University Press) 1993. When procedure which Pythgoras experimented with the monochord in the 6th century B.C. re-enact today, that is: when pulling such a string, actual re-enacting the techno-physical insight of the relation between integer numbers and harmonic musical intervalls which once led Greek natural philosophers to muse about the mathematical beauty of cosmic order in general; in terms of cultural discourse, certainly not same situation like Pythagoras; "historical" circumstances, even the ways of listening and the psycho-physical tuning of our ears, is different. Still, the monochord is a time-machine in a different sense: It grants participation at the original discovery of musicolgical knowledge, since - the techno-original experience is repeatable; the re-enacted experiment allows for com/munication across the cultural-historical gap by providing a storage-channel; reverberating chord is an operative sonic media diagram. Charles Sanders Peirce describing diagrammatic reasoning: "[...] similar experiments performed upon any diagram constructed to the same precept would have the same results [...]."[587] Once human senses are coupled with a technological (especially sonic) setting, man is within its autopoietic temporal field, a chrono-regime of its own dynamics (or mathematics, when data are registered digitally). Such couplings create moments of literal ex-ception: Man is taken out

[587] Charles S. Peirce, The New Elements of Mathematics, vol. IV: Mathematical Philosophy, The Hague / Paris (Mouton) / Atlantic Highlands, N. J. (Humanities Press) 1976, 48

of the man-made cultural world (which is Giambattista Vico's definition of "history") and confronts naked physics and / or pure logical reasoning.

Archeo-acoustic phonautography? *Time Shards* in the media-active test

- video-interview of a fictitious archaeologist, with sonagrams under the title *Le Vase* (Internet search term: "ancient sound / archaeology" = www.zalea.org/article.php3?id_article=496

- reverse phonography / acoustic media-archaeology: SF; orig. 1979; *online* 2000: Gregory Benford, *Time Shards*: "As workers at the Smithsonian prepare a time capsule to be buried in 2000 AD, a scientist tries to resurrect voices from 1000 AD" (Robert J. Sawyer); listen to the voices of people from a thousand years ago by rading grooves on pottery = www.fictionwise.com/ebooks/eBook243.htm

- convert the grooves in ancient pottery (Roman vases from our Archaeology Department) by gramophonic sampling into analog and digital signals, by software-based signal-to-noise analysis separating any trace of phonetic articulation from the scratch of the material (signal-to-noise ratio); Wolfgang Heckl: apply nano-physical research tools; double sense of German "Tonspur" (record groove)

- sonifying the grooves in ancient Roman poettery by phonographic pick-up (typo "pottery / poetry"; oral poetry audible again from ceramic shards; Gregory Benford's short story *Time Shards*); converting the grooves of Roman vases borrowed from Archaeology Department by gramophonic sampling into analog and digital signals, trying by software-based signal-to-noise analysis to separate any trace of phonetic articulation from the scratch of the material; due to signal-to-noise ratio no exciting results so far. Heckl advises to apply much more sensistive measuring instruments / filter algorithms to carry on the experiment

- archeo-acoustic hypothesis: sound inadvertently recorded before the phonographic developments of Scott and Edison; unfavoruable signal-to-noise ratio, though; first of all, such media archaeology remains technologically close to the signal (including the physical or mathematical "veto"); only on that basis epistemological speculation shall start

- about accidental recordings or archeo-acoustics: "[...] my view is rather negative on this idea. Sound evolves over a timescale measured in milliseconds, if not less. In order to record sound people had to find media which could a) be deformed in response to sound on that time scale, and then b) which would hold that deformation stable for periods exceedingly long (years, centuries)" = communication Carl Haber, October 2012; functional materials soot on paper (Scott), tinfoil (Edison), and wax (Bell and Tainter), later lacquer, plastic, and special soft aluminum which could be embossed. "In archeo-acoustics people instead focus on soft 'paste' like materials such as clay and ink. In these cases the materials will flow if disturbed, under gravity or density gradients and eventually seek their own level in equilibrium. Any effect from sound will be erased or severely attenuated. Furthermore any simple transducer, such as a needle or stylus, will itself couple very poorly to the sound pressure field in the room so not transfer energy in an efficient way. This is why Scott and the rest later all used horns as well. The archeo-acoustic mechanisms lack such an impedance match as well" = Haber ibid.

Siren songs

- contrary to Walter Benjamin's anecdote of the dwarf within the mechanical chess-player, media archaeology referring to the inhuman mechanisms within the human itself; vocal automata no more represent an allegoric discourse about the instrumentalization of the human body, reveal the automativity within the animal

- reverse phonography as acoustic media-archaeology; experimentally realistic by the options of quantum microscopic reading of atomic surfaces; Gregory Benford, *Time Shards*, orig. 1979; *online* 2000: FictionWise eBooks. "As workers at the Smithsonian prepare a time capsule to be buried in 2000 AD, a scientist tries to resurrect voices from 1000 AD" (Robert J. Sawyer) by reading grooves on pottery = www.fictionwise.com/ebooks/eBook243.htm

- Wolfgang Heckl, "fossil voices"; sound of the past (still) in the air, if it is understood in its physical nature which is (calculable) vibrations, as expressed by Charles Babbage in his *Ninth Bridgewater Treatise*: "The track of every canoe, of every vessel which has yet disturbed the surface of the ocean, whether impelled by manuel force or elemental power, remains for ever registered in the future movement of all succeeding particles which may occupy its place. <...> and these again once moved, communicate motion to others in endless succession."[588]

- discrete pulses, acoustic signal processing, resulting in an instrumental siren, developed by Charles Cargniard La Tour in 1819; improved by Hermann v. Helmholtz, linking sound production to the mathematics of Fourier series

- Edgard Varèse, in his piece *Ionisation*, performs "corporification de l'intelligence qui est dans le sons" with technical siren

- with optical film soundtrack end 1920s, sound photoelectrically recorded on a narrow track beside the images, "and the fact that it is visible means that is can even be monitored and analysed. Most of the photoelectric organs and organ-like instruments from the late 1920s and the 1930s were based on the mechanism of a rotating disc that interrupted the passage of a beam of light between its source and a photocell <...>, thus avoiding the wear and tear of direct contact with the surface of the recording. Many of these systems used a principle derived from that of the siren [...] a rotating opaque disc in which holes or slits had been cut" = Davies 1994: 6; Abb. = 7; synthetic sound; a technical "vocoder"

Technological de-humanizing of oral testimony

- digitally mediated oral testimony not simply a modification of "mediated memory" but a radical gap - both in epistemological terms and in the phenomenology of temporal experience; de-humanization of "digital testimony" both a tragedy and a productive chance for different experimentation (and experience) of cultural memory and a re-definition of the human in the neo-cybernetic sense; co-induction of voice testimony by technolgy itself

- in times of digital sound recording and processing, no more "noise" (traumatic intrusions of the real) in listening to phonographed voices from the past; silence of the noise of the apparatus as "historical" testimony even more sub-traumatically irritating to the senses (case audio CD)

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[588] The Works of Charles Babbage, ed. Martin Campbell-Kelly, vol. 9: The Ninth Bridgewater Treatise. A Fragment, 2nd ed. 1838, London (Pickering) 1989, Kapitel IX, 37

"Bad recording" of beautiful voices

- obsolete *Conquest of Space* record with communication by cosmonaut Gagarin to Moskow, basis for electro-acoustical composition by Nick Fells; is it exactly its non-archival quality which makes "bad recordings" exciting for media archaeology. the recording medium articulates itself and does not simply transport cultural content; cp. a recording of Donezettis Lucia di Lammermoor as performed in the Milano Scala in 1954. After some while, somewhat like out of space, a radio transmission interference happens. This is the noise from which media-archaeological theories derive.

- direct recording of Callas' voice from 1954 concert *Lucia di Lamermore* in Scala, Milano; for radio broadcasting nowadays considered almost unplayable as so-called "bad recording", normally accompanied by an excuse by the classic radio Dj; "Callas"; *as if* perceived by short wave radio: Tenor, in Gaetano Donizettis *Lucia di Lammamoor*, recording Scala Milano, 1954 under Karajan. In the midst a radio signal interferes with the concert recording itself.

- Callas' voice rivalling with microphone distortions, demanding for close listening with media-archaeological ears; radio wave interference with cultural soundings. When broadcast in German Kulturradio, the speaker in advance apologized for "bad" recording; positively defend the medium expressing itself, documenting; opera recordings from the past in 20th century is possible only by means of technologies; critically (or ironically) allow them to be co-enunciative

Let the medium speak: ghost talk

- controlling noise by mis-interpreting it as communication; in the electronic media age, the medium to speak with the dead is not texts any more, not literature, but radio; tuning of a radio in search not only for channels but for the inbetween of channels (the noise intererential spaces) functions only with analog radio sets, with an „elastic“ scale

- against "noiseless" digital aesthetics, electronic analog media still know what noise is; radio jamming interpreted by the human ear (which immediately, as cognition, strives to makes sense or at least message or at least melody out of noisy signals) as voice from beyond (noise): „No Morse-code, nor a radio amateur“

Martin Heidegger's radio

- for his hut in Todtnauberg, Heidegger acquiring a radio on the climax of the Cuba crisis in 1962 for the global fear a world war might actually break out. In spite of Heidegger's critical remarks on the implications of radio, he submittet to the medium exactly at the place which seems to be the remotest from all technology (otherwise, there was just one electric bulb in the hut). Heidegger_s son actually gave be the exact type number ot this radio; the Media Archaeological Fundus acquired a radio set from the same series which now is stored in the media-archaeological collection at Humboldt University. Such concrete medium archaeology extends within the frame of questioning media temporality.

"Radio silence"

- mid August 2014, an apology *via* e-mail (notably from the editors of the *online* journal Mnemoscape): "I do apologize for the prolonged radio silence." Wörtlich genommen, in terms of radio as electro-magnetic event, the carrier frequency communicates even if there is no modulated signal to be detected (technically: demodulated) and thereby to be transduced to the human ears. Semiotically "empty" radio is still a pure message of the medium (just as McLuhan defined electric light, in the first chapter of *Understanding Media*). If sound is bound to the audible, it belongs to phenomenology: "Phenomenology is a logos (a discourse) of the phenomena (the things that are visible)"[589] - or audible. "It is distinct from and in opposition to what we might call noumenology - the logos of the noumena: the invisible things, the things that belong to nous (the mind, consciousness, logos itself)" - which is the symbolic regime (alphanumeric codes) = Scannell 2014: 5; inbetween sonicity: time-signals which happen, even if they are not phenomenologically audible

- 2014 international conference organized by Czech Radio on the topic *Stream and Form – Two Options and Two Strategies of Public Radio Broadcast*; transformation of current media (radio and television) tempor(e)alities; how radio's proper "shaping of time" changes a) with the transformation from hardware-based proper radio technology to Internet-based radio as a data format among others (what is lost when radio is not an independent media technology of its own engineering rules any more but becomes a function of general computing), and b) how does the online aesthetics of immediate access challenge the traditional form(at) of "edited" time in radio broadcasting; radio thereby losing its distinctive qualities as an independent technology and becomes subjected by the real-time economy of Internet time

Techno-traumatic irritations

- traumatic momentum from micro-shocks technologically induced in human media perception; whether the audio-visual "witness", once digitized, on most essential technological level looses its indexicality; does Shannon / Nyquist sampling theorem for analog-to-digital signal conversion actually guarantee that the indexicality of the signal remains intact? "Part of the implicit ideology of digital audio is that with increasing sample rates and bit depths we come closer and closer to representing the real, but the 'real' seems to recede from each attempt to grasp it"[590]; central aspect of "Digital Humanities" addressed thereby

- "traumatic" moment in analog media testimony resulting from the phonographic presence of the voice in re-play; photographic *punctum* as identified by Roland Barthes; Markos Hadjioannou, From Light to Byte. Toward an Ethics of Digital Cinema, Minneapolis: Univ. of Minnesota Press, 2012, esp. 50 ff. on Alain Resnais' documentary film *Night & Fog* from 1955) and the indexial trace of light in electronic video; Laura U. Marks, Touch. Sensuous Theory and Multisensory Media, Minneapolis: Univ. of Minnesota Pr., 2002; Mary Ann Doana, The Emergence of Cinematic Time, Cambridge, Mass. / London: Harvard UP 2002), with the digitization of such technical records their status transformed or even "transsubstantiated" (to borrow a term from Christian liturgy) in technological, historical (source) and ethical (Holocaust

[589] Paddy Scannell, Television and the meaning of live. An enquiry into the human situation, Cambridge (Polity Press) 2014, 5

[590] Peter Price, Resonance. Philosophy for Sonic Art, New York / Dresden (Atropos Press) 2011, 85

memory) ways

- "algorhythmicized testimony" (proposal Amit Pinchevski); a looped timing of the digital Yale Holocaust Archive voices. "Data *processing* is the name given to the manipulation of data to produce a more useful form, which we shall call *information*. <...> The sequene of operations required to perform a specific task is known as an *algorithm*" = J. D. Richards / N. S. Ryan (eds.), Data Processing in Archaeology, Cambridge U. P. 1985, 1 f.

Archiving Presence: From Analog to Digital

- “Archiving presence” a deliberate oxymoron; implies both storing and re-storing, recording and regenerating presence-effects; Edison’s 1877 invention of the phonograph enabled the acoustic recording of the dis-embodied voice; induced a cultural shock whose impact still resonates nowadays; dissonance between cognitive knowledge (the historicity of the recording, the knowledge that it is already in the past) and its neuro-physiological effect (the perception of the voice as pure presence, always in the present) = Mladen Dolar, A Voice and Nothing More, Cambridge, Mass. / London (MIT Press) 2006 [= Eine Theorie der Stimme, Frankfurt/M. (Suhrkamp) 2007]; there is no "past" in sonic articulation

- Amit Pinchevski / Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial , in: Public Culture 22:2 (2010), 265-291, note 2: Orson Welles’s radio dramatization of H. G. Wells' *War of the Worlds*, aired in October 1938, caused widespread panic among audiences who thought Martians were actually about to invade New Jersey: by the (simulated) collapse of the broadcasting network itself; Dayan, Daniel, and Elihu Katz. 1992. Media events: The live broadcasting of history. Cambridge, Mass.: Harvard University Press

- Anthony Enns, Voices of the dead: Transmission / translation / transgression, in: Culture, Theory and Critique vol. 46 (2005), 11 – 27

Techno-Trauma: From Analog to Digital

- media-archaeological shift of attention to a more fundamental level: traumatic affects as immediate functions of the technological pre-conditions themselves. When coupled with human perception, electronic and algorithmic media operations result in specific irritations of the human sense of time.

- the phonographic affect; un/like photographic *punctum* short-circuiting historical distance described as an affective temporal indexicality in direct relation to photo-sensitive chemicals; Roland Barthes, La chambre claire. Notes sur la photographie, Paris (Gallimard / Seuil) 1980 [Camera Lucida. Reflections on Photography, trans. Richard Howard, New York (Hill & Wang) 1981

- cultural shock induced by the first recordings and re-playing of voices by the Edison phonograph yet to be digested in occidental cultural epistemology and logocentrism; modelling of the human unconsciousness according to binary machine logics by Jacques Lacan has finally undermined the self-understanding of a privileged human subjectivity - an ongoing irritation of presence

- a special class of traumatic temporality from the technological re-conditioning of temporal experience itself

- unarchivable presence as definition of "traumatic" memory

- in a theatre play from 1924 *Katalaunische Schlacht* (by Arnolt Bronnen) a grammophone acts itself which haunts the actors by a spectral (in all senses) repeatable voice - literally "nachgetragen" (*nachträglich*) = Lethen 2014: 205

- traumatic voice memory not only belated but ante-cedant, already inherent in the affective shock (the "Nipper effect", figuring as the visual icon on HMV records), induced by the experience of the technologically dis-embodied voice

- cybernetic machines exhausting the smallest interval (Max Bense)

- "out-of-sync" (the missing half-second); Herta Sturm: empty time interval vs. Massumi: full interval

- Speech Synthesis and the Uncanny (Nikita Braguinski); Freud, *Das Unheimliche*, referring to Ernst Jentsch: doubts about wax figures / automata: (no) consciousness; boundary between human / inhuman is blurred in artificial dolls (Edison records inside); technical *embodiment* of the voice; see Blanchot, "Sirens"; resulting in the uncanny feeling about one's own partial functioning as machine

- Norwegean composer Christian Blom creating uncanny encounters of mechanical acoustics and electr(on)ic current, such as al Khowarizmis Mekaniske Orkester = algorithmic orchestra (with the sequence of operations computationally / stochastically programmed?); Shintaro Miyazaki's research on the "algorhythmic"; true media-archaeological sonicity, and recurrence of the sirens: The Singer; https://vimeo.com/user47473836

"Prayers of a Phonographic Doll"

- Anderson Blanton; question of presence, especially in relation to technicity / materiality of phonographic prayer; http://forums.ssrc.org/ndsp/2014/01/29/prayers-of-a-phonographic-doll

- the uncanny of death (the ultimate sublime sensation of the "real" according to Lacan) is thus dis-locafted from metaphysics to the machine

- Walter Rathenau's essay on "Resurrection Co."; telephonic connection of the grave to the living

- with the prayer machine, the traumatic (here: death as subject of prayer) is dislocated from the symbolic (reading) into the real of the machine itself (the "speaking doll"), thus: really techno-traumatic (in fact, does this not challenge "the social" as agency?); related to the issue of the uncanniness of "Sirenic voices"

- "The doll's mechanical recitation marks an important technological shift in the practice of teaching children to pray. The child's private devitions are no longer founded upon a particular [...] practice of phonetic alphabetization and the concomitant 'hearing' or the silently read biblical passage as a divine coice withinthe mind." In the case of the speaking dolls, the child

does not learn the alphabet from the mother's mouth any more but from the machine; text-to-speech program

Phonographic recursion of the phonetic alphabet

- 1878 Edison describing in a patent one of the possible uses of the phonograph as speech generator, "to teach the relationship between each letter of the alphabet and its sound: a set of typrewriter keys, each labelled with a single letter, activated the playback of individual sections of a long cylinder that contained the spoken forms of those particular letters"[591] - a media-archaeological (rather than "historical") recursion of a cultural technique, since not immediately reflected in cultural terms - when the invention(s) of the discrete alphabet (as opposed to ideographic writing systems) cut down the human language into smallest elements which are meaningless in themselves, from house (*beta*) to "B", so to say. At this moment the machines take over, since only machines can perform symbolic operations without any semantic referentiality (which hinders effective data processing), purely syntactically; signal processing rather than semiotics, mediatic operativity rather then cultural "performance"

Historical *versus* media-archaeological reconstruction of sonospheres

- novel from 1880, *L'Eve Future*, Vielliers de l'Isle-Adam: before the phonograph any sonic expression (be it speech or music) had to be symbolically transformed into music notation in order to survive in time; with technical recording sound immediately becomes inscribed into a non-historical, non-human, signal-based material medium which literally has to get in motion (like the turning disc or the hard drive) in order to get re-presenced. By electroacoustic recording, "the concept of a linear flow of time becomes an anachronism"[592] itself. The formerly "historic" relation between presence and past is replaced by resonance; *sonicity* refers to the implicit tempor(e)ality which is connected with vibrating, oscillatory and frequential articulation; Steve Goodman, The Ontology of Vibrational Force, in: same author, Sonic Warfare. Sound, Affect and the Ecology of Fear, Cambridge, Mass. (MIT Press) 2009, 81-84. If the signal being transmitted is *continuous* (“as in oral speech”) rather than being formed of *discrete* symbols (“as in written speech”), this fact affects the message (Weaver, 1963: 8)

- Marcel Proust making the reader think *of* bygone times, but when hearing Kirsten Flagstad as Isolde, with the Royal Opera House Orchestra under the leadership of Sir Thomas Beecham, her voice *is* concretely present to the perceptive mind. "The intellect tells me that the recording is 72 years old and stems from Covent Garden, but for my senses, she is with me in space, here and now." Jakobsen 2010: xxx

- Greek vocalization of the Phenician alphabet symbolically emulates, by recording (grammo-phonically), the musical character of oral poetry (notably the epics of Homer); even the phonograph reaches its limits when it comes to record the purely physical noise: "Ansi, j`eusse blâmé, par exemple, le Phonographe de son impuissance à reproduire, en tant que *bruits*, le bruit ... de la Chute de l'Empire romain ... les bruits qui courent ... les silences *éloquents* ..."[593]

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[591] Hugh Davies, A History of Sampling, in: Feedback Papers 40 (Juli 1994), 2-15 (4)

[592]Barry Truax, Acoustic Communication, Norwood, N. J. (Ablex) 1984, 115

[593] Edition Lausanne (L'Age d'Homme) 1979, 36

- signal semantics in Steve Reich's minimalist composition *Different Trains*: acoustic memories of former train journeys, indexical *train sounds* combined with human testimonies (*voices of train porters*)

Indirect transmission of sound (the vocal alphabet)

- Aristotelean correlation of time-number-movement; the over-countable in-between (dynamic *to metaxy*); phonographic signal recording in privileged alliance with the physically "real" acoustic articulation = Friedrich Kittler, Die Welt des Symbolischen - eine Welt der Maschine, in: ders., Draculas Vermächtnis. Technische Schriften, Leipzig (Reclam) 1991, 58-80 (68), unter Bezug auf: Jacques Lacan, 1973-80, in: Schriften, hg. v. Norbert Haas, Olten-Freiburg/Br., Bd. I, 24

- "chronotechnics" in adaption of Aristoxenos' term *chronoi* as smallest units ot time in rhythm: long, short, intervals; extend / re-actualize to digital computational cycling units; See introduction Lionel Pearson, to: Aristoxenus, Elementa Rhythmica. The Fragment of Book II and the Additional Evidence for Aristoxenian Rhythmic Theory, Oxford (Clarendon Press) 1990, xxxiv. Pearson ergänzt: "One of the difficulties in reading Aristoxenus is to distinguish the special or technical use of a word from its general meaning. Greeks of his time were devising their own technical and scientific terminology" = ibid., note 20

Sound archaeology

- sampling rate of 48 kHz with quantization of 16 bit linear storage

- listening to human voices which exterminated hundred years ago, by applying laser reading of the wax cylinders which do not destroy its source in the act of re-play; play-back in exactly the same quality as the Indian natives could in 1907. An example of the opto-eletronic archaeology of sound can be appropriately experienced right in the World Wide Web.[594] What do we hear: Message (the formerly recorded songs) or noise (the scratch; recording primarily memorizes the noise of the wax cylinder itself - which is not cultural-historical, but cultural-technological, a different kind of impression of the real. Media archaeology opens our ears to listen to this as well, not to filter this out against the "cocktail party effect" of hermeneutics

- by media-archaeological operation of opto-digitally reading of inscribed traces, otherwise unaccessible sound recording audible again. Synesthetically, *see* a spectrographic image of sound memory; spectrogram of a reconstructed recording of Wedda chants in Ceylon 1907 on the SpuBiTo web page; micro-physical *close reading* of sound, where the materiality of the recording medium itself becomes poetical[595], dissolves any semantically meaningful archival unit into discrete blocks of signals. Instead of musicological hermeneutics, the media-archaeological gaze is required here - a reminder of light-based sound inscription in early film

[594] http://www.gfai.de/projekte/spubito/index.htm; now expired: see archive.org "Wayback Machine"

[595] See Karl Sierek, Die weiße Leinwand, in: ders., Aus der Bildhaft. Filmanalyse als Kinoästhetik, Wien (Sonderzahl) 1993, 115-130 (122), referring to: Umberto Eco, Semiotik, 263 f.

- noise, the scratch of the wax cylinder the pure message of the medium; inbetween, the human voice is literally incorporated. But what has been continuously been preserved by analogue recording technologies, becomes quantified in the transfer to digital recording (CDs). When sampling a continuous wave with an analog-to-digital converter, sampling rate controls how many samples are taken per second; the sampling precision controls how many different gradations (quantization levels) are possible when taking the sample

Technologies of sonic tradition: a signal-to-noise ratio

- what articulates 'it'self in human / nonhuman communication in any transmission channel is noise, against which Shannon developed a primarily "mathematical theory of communication" *alias* digital media; extending Shannon's theorem to transmission in time as well, that is: tradition. In such noise articulates itself what baroque allegories showed as the nagging „tooth of time“ - the articulation of physical entropy, the manifestation of the temporal arrow; according to the Second Law of Thermodynamics each system tends, over time, to increasing dis-order. Noise, here, is a signal of entropy. Against this noise of the real culture (especially techno-logical, that is: „digital“ culture) poses a negentropic insistance, a negation of decay and passing (away)

- digital copies of digital records indeed producable almost without loss of data (except the quantization noise). Music on Compact Disc or a digitale video can be reproduced frequently with stable quality which was utopean in recent times of analoge recording on magnetic tape; secret of this temporal unvulnerability is that it is just (physical representations of) numbers which are written on the Compact Disc; even after a thousand copies thus a zero stays zero and one remains one[596]

- natural sound evasive, liquid, in itself unrecordable beyond the bodily range, but technical media (different from alphabetic phonetic writing which "freezes" the human voice into a range of a very limited symbolic code) able to de-freeze recorded voices in almost all frequencies (that is, the Lacanean "real" of the voice) by re-play. After two millennia of the phonetic alphabet there is a new kind of cultural technology as sound recording

Berlin Lautarchiv

- target of sonic analytics not individual speech in terms of meaningful content, but subsemantic insights which can be derived from the very materiality of sono-cultural articulation: *phoné* (German "Laut").[597] Very literally, the phonographic collection of early voice recordings (Lautarchiv) based at Humboldt University, Berlin is an ideal subject for such a sonic archaeology. The Lautarchiv encompasses three groups: a) Famous voices (which for political reasons were partly neutralized or even destroyed after 1945); b) truly archival recordings of local speech dialects, based on a set of artificial word sequences in order to achieve formal comparability (so-called Wenker-sentences) with the speed of the recording beeing controlled

[596] Rudolf Taschner, Der Zahlen gigantische Schatten. Mathematik im Zeichen der Zeit, Wiesbaden (Vieweg) 3. Aufl. 2005, Anm. 77

[597] For several socio-linguistic and computer-based analyses in the techno-culturally variant coding of human voice frequencies see Zakharine / Meise (eds.) 2013

by a supplementary oscillographic time code, and c) recordings for musical ethnology (mostly Africans and Indians from the French and British Army in the World War One *Halbmond* prisoner camp at Wünsdorf south of Berlin)[598]

- almost complete list of the both phonographically and symbolically registered recordings online: http://www.sammlungen.hu-berlin.de/sammlungen/78

- phonographic recordings since April 1920 integrated as Department of Phonetics (*Lautabteilung*) into the Prussian State Library in Berlin to be reproduced on schellack discs *and* as transcription for educational distribution[599]; original relation between spoken orality and its *grama*-phonic derivative (the phonetic alphabet) reversed again by the intrusion of real audio signals into the symbolical order of the librarians' Gutenberg world of letters, resulting in a kind of animated phonetic library: "Die toten Buchstaben und Büchertexte werden hier durch die Ergänzung der Lautplatte lebendig und verkörpern eine wirkliche Lautbücherei" = Wilhelm Doegen, Die Lautabteilung, in: Fünfzehn Jahre Königliche und Staatsbibliothek 1921, Berlin (Preußische Staatsbibliothek) 1921, 253-258 (253)

- architectural front facade of German Library in Leipzig (Deutsche Bücherei), founded in 1913, displays a monumental quote from a Schiller poem: "Körper und Stimme leiht die Schrift dem stummen Gedanken [...]"; printed text as it were starting to "speak" from a gramophonic storage medium which (different from the alphabet) does not discriminate between signal and noise any more: "In Graphie und/oder Phonie des Titelworts `Sprache´ steckt die Lautverbindung 'ach'" = Friedrich A. Kittler, Aufschreibesysteme 1800 / 1900, München (Fink) 1985, 48. *Lautabteilung* consequently accumulates natural and artificial noise („Geräusche natürlicher und künstlicher Art und andere“) such as the sound of tree leaves in the wind. What had started as interlinear auditory hallucinations in romantic literature becomes real in sub-symbolic recording media. The gramophonic recording method for waveforms in the so-called *glyphic system* on wax discs inscribes even sonic warfare into the new cultural memory as *écriture automatique*: "Gewehrfeuer (gun fire) for a theory of sonic explosion, and the sound of air planes ("Fliegergeräusche") = Doegen, op. cit.

- detecting minute variances and to eliminate subjective inexactitudes in listening to the recordings of foreign dialects and voices; limits of hand-written phonetic transcription become obvious, leading instead to the application of visual oscillograms and Fourier Analysis of the phonetic wave forms: Alois Brandl, Lebendige Sprache: Beobachtungen an Lautplatten englischer Dialektsätze, mit einem Anhang von Wilhelm Doegen, Zur Lautanalyse aus dem Klangbild des englisches Dialektwortes "man", aus der Lautplatte gewonnen nach dem elektro-oszillographischen Verfahren, in: Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften, Phil.-hist. Klasse (1928), 72-84

- when explicit listening replaced by technographical measuring of sonicity, gap between cognitive musical understanding and physical recording (the material, tonally *integrative* engraving of a musical event in the phonographic groove) opens. Just like the point of the gramophone needle can make only one movement at one time, "the illuminated disk of the

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[598] See Britta Lange, Ein Archiv von Stimmen. Kriegsgefangene unter ethnografischer Beobachtung, in: Nikolaus Wegmann / Harun Maye / Cornelius Reiber (eds.), Original / Ton. Zur Mediengeschichte des O-Tons, Konstanz (Universitätsverlag) 2006, 317-341 (esp. 335 f.)

[599] Lautbibliothek: Phonetische Platten und Umschriften, ed. by the Lautabteilung der Preußischen Staatsbibliothek, 1920 onwards

oscilloscope shows only one line, no matter how many tones are sung into the microphone simultaneously. [...] what the apparatus registers as *one* wave, we *hear* as *multiplicity* of tones - and as a organized multiplicity. [...] mathematical analysis of the shape of the line permits us to deduce the individual waves that are combined in it. Yet [...] our ear accomplishes, effortlessly, continuously, and instantaneously, what costs the skilled mathematician a considerable expenditure of time and energy"[600] - until the Fast Fourier Transform algorithm arrived in real-time digital computing of sound. Even the much more detailled spectral voice analysis which had just been developed in Zuckerkandl's generation subjected the complex dynamics of sonic events once more to the visual knowledge regime since sonagrams, though expressing delicate micro-temporal variations, tend deciphered analog to alphabetic writing.[601] But the tempor(e)ality of sonicity can never be caught in a frozen state but always points beyond the moving still - as has been discussed by Bergson's critique of chronophotography and the cinematographic illusion of "movement".

- ancient phonetic oscillograms today represent the truest media-historiography of that time - while at the same time challenging the historical narrative of their recording context. The real archive of sonic articulation emanating from such recordings is no longer literary stories but numerical analysis - finally resulting in digital sampling of the analogue records which is the transduction of ghostly voices into computability

- focus of sonic analysis in a *Lautarchiv* on the materiality of sound equally valuable in its acoustic and its technological sense. In modern Greek radio broadcasting is called *radiophonia*. Analog to telephony, not speech or music as semantic content is named here, but the phonetic materiality (ancient Greek *phoné* / German *Laut*) of any kind which is transmitted by a neutral medium called radio. In terms of a (media) archaeology of acoustics, the nature of sound is spectral, thus undermining the symbolical (Pythagorean) order of harmonic tonal relations in integer numbers - just as the letters in an alphabet only symbolically relate to the phyiscality of actual speech phonems which are as "differential" (Arseny Avraamov) as the *glissandi* of the Theremin Vox contructed as the first mass-reproduced electronic music instrument by Leon Thermen in revolutionary Soviet Union.[602] With sound production which is subliminal to human perception, sonicity (different from sonority) starts.

"First Sounds" (Patrick Feaster): (Archaeo-)Phonography *avant la lettre*

- "archival" operation extends from restauration and conservation to re-animation and thus becomes a true media-archaeological operation; in novel called *Time Shards*, the science fiction author Gregory Benford imagines a research laboratory which reconstructs "fossil voices" out of the grooves of mediaeval pottery

- Patrick Feaster and David Giovannoni succeeding in re-sonifying the preserved phonautographic engravings ("Schallbilder"), beginning with Scott's recording of a sound folk

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[600] Victor Zuckerkandl, Sound and Symbol. Music and the External World, New York (Pantheon) 1956, 333f

[601] See Ralph K. Potter / George A. Kopp / Harriet C. Green, Visible Speech, New York (Van Nostrand) 1947, and Boris Yankovsky's sound spectrography (as mentioned above).

[602] See Andrey Smirnov, Sound in Z. Experiments in Sound and Electronic Music in early 20th Century Russia, London (Koenig Books) 2013, 44

tone of 435 Hz in the year 1859. 150 years later science realized that with optical "reading" of such acoustic signal lines sound can be re-synthesized, and all of the sudden a children's song sounds again: Lèon-Scott, phonautographic recording 8th April 1860, Paris: "Au clair de la lune, Pierrot répondit"; *online* http://www.firstsounds.org/sounds/1860-Scott-Au-Claire-de-la-Lune-09-08.mp3

- what metaphorically looks like the pick-up of sound images by a "virtual, digital gramophone needle"[603], in fact is something media-epistemologically different, a picking-up of a completely new kind: digital sampling

- Edison phonograph announced in the journal *Scientific American*: "That the voices of those who departed before the invention of the wonderful apparatus <...> are for ever stilled is too obvious a truth; but whoever has spoken or whoever may speak into the mouthpiece of the phonograph, and whose words are recorded by it, has the assurance that his speech may be reproduced audibly in his own tones long after he himself has turned to dust. <...> A strip of indented paper travels through a little machine, the sounds of the latter are magnified, and our great grandchildren or posterity centuries hence hear us as plainly as if we were present."[604]

- technical media (different from alphabetic phonetic writing which "freezes" the human voice into a range of a very limited symbolic code) able to de-freeze recorded voices in almost all frequencies (that is, the Lacanean "real" of the voice) by re-play.[605] After two millennia of the phonetic alphabet there is a new kind of cultural technology as sound recording

- literally retrieving *signals* from the past, new privileged ways of connecting to the past *via* the communication channel rather than by the coded symbols (the traditional archival record). But this signal channel is cut by the digital sampling of such records, such as the software IRENE which reads out graphical grooves by the „virtual stylus“ and audifies them (at the Berkeley Laboratory, by Carl Haber) = argument in Patrick Feaster's lecture "Sound Archives *avant la lettre*: Audio Collections of the Nineteenth Century (1850s-1890s)", conference *Listening to the Archive. Histories of Sound Data in the Humanities and Sciences*, 11-13 February, 2016, Berlin, Humboldt University / Max Planck Institute for the History of Science

- performed with the free, open access software ImageToSound - which at the same time, media-archaeologically, recalls the technical epistemology of the sound film (*Lichtton*)

- inbetween the alphabetic metaphor and signal reproduction, the "Graphophone" has been the name for play-back device for phonographic records

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[603] Harald Haack, Die erste Klangaufzeichnung. Eine Audiografie, *online* http://newsbattery.blogsport.de/2008/05/07/die-erste-klangaufzeichnung-eine-audiografie

[604] Anon. (The Editor), A Wonderful Invention - Speech Capable of Indefinite Repitition from Automatic Records, in: *Scientific American*, 17. November 1877, 304; see chap. 6 "A Resonant Tomb", in: Jonathan Sterne, The Audible Past. Cultural Origins of Sound Reproduction, Durham / London (Duke University Press) 2003, 287-334 (297 f.)

[605] See John Durham Peters, Helmholtz, Edison, and Sound History, in: Lauren Rabinovitz / Abraham Geil (eds.), Memory Bytes. History, Technology, and Digital Culture, Durham / London (Duke University Press) 2004, 177-198

- phonographic groove is a „graph of a sound over time“ (Feaster): mathematical derivative (*Ableitung*) over time; a kind of analog computing

- can time rate of the retrieved sound be defined if there is recording of an accomanying pilot tone as well, such as on Scott de Martinville's phonautograms by means of a tuning fork

- reading out from handwritten archival „manuscripts“ the modulated overtones which vibrated (when speaking while writing aloud, like in early Greek and Medieval times): overlay; separate by Fourier analysis

- revolving form of the Edison cylinder respectively the gramophone disc is necessary for machine reading since a time signal unfolds, different from human reading which can be non-linearly arranged line-wise on the geometric writing page

- audifying very first phonographic recodings efforts by Éduouard-Léon Scott de Martinville resulted in indiscernable noisy patterns: *Message ou Bruit?*[606] From what moment on can we speak of „first sound“ or „speech“ records? Here, the media-archaeological moment starts to irritate human cognition. Media-archaeological work which steays close to the signal is non-hermeneutic "understanding" of cultural expression

Active media archaeology: Sonic revelation (articulation) from the past (*Au Claire de Lune*)

- historical research academically a text-based science, opposed to a science of signals which has opened a new field of research not just as an additional source for historical inquiry; with photography, the phonograph and with cinematography an alternative field of agenda set

- so-called Humanities (as defined by Wilhelm Dilethey) not sufficiently concerned with the physically real - due to the limits of hermeneutics as text-oriented method, to the priligeging of narrative as dominant form of representation and because of an essential lack of non-symbolic recording media of the real. Battles have been described and interpreted, but the real noise and smell of a combat could not be transmitted until the arrival of the Edison phonograph[607]

- phonography not just helping historiography to higher precision; rather explores new forms of tempor(e)ality on the level of the physically and mathematically real (techno/logy); get tuned to this new epistemology, not by texts and the spoken word, but by a French childrens' song: *Au Claire de Lune*. In an act of active media archaeology by the computer itself is has been achieved that the graphic recording of Léon Scott's analyses of the human voice could be re-transformed into acoustic artikulation

- phonautogram by Lèon-Scott, recorded 8th April, 1860, Paris: song "Au clair de la lune, Pierrot répondit"; http://www.firstsounds.org/sounds/1860-Scott-Au-Claire-de-la-Lune-09-08.mp3

[606]Lecture title by Michel Foucault, read at a conference of medical research in Paris, xxx

[607] See Bernhard Siegert, Das Leben zählt nicht. Natur- und Geisteswissenschaften bei Dilthey aus mediengschichtlicher Sicht, in: Claus Pias (ed.), Medien. Dreizehn Vorträge zur Medienkultur, Weimar 1999, 161-182 (175), referring to: Wilhelm Dilthey, Die Abgrenzung der Geisteswissenschaften. Zweite Fassung, in: same author, Gesammelte Schriften VII, 311

- from such an operation, re-discovery of a song expected, but what primarily acoustically emanates is noise - just like the first (archived) recording of sound in Norway, a tinfoil flattened to a "document" and annotated by a remark by a former collector who claims this has been the first Norwegian recording of music on Edison cylinder; digital reading of this record (at a laboratory in Southampton) lead to nothing but noise

- What articulates as almost Freudean "it"self is noise such as can be expected in any transmission channel according to the theory of communication developed by Claude Shannons - a theorem which can be extended to transmission in time as well, that is: tradition. In such noise articulates itself what baroque allegories showed as the nagging "tooth of time" - the articulation of physical entropy, the manifestation of the temporal arrow; according to the Second Law of Zweiten Thermodynamics each system tends, over time, to increasing dis-order

- against the noise of the really physical world, culture (especially techno-logical, that is: "digital" culture) posing a negentropic insistance, a negation of decay and passing (away).

- Digital copies of digital records can be produced almost without loss of data (except the quantization noise[608]). Music on Compact Disc or a digital video reproducable frequently with stable quality which was utopean in recent times of analoge recording on magnetic tape. The secret of this temporal invulnerability is that it is just (physical representations of) numbers which are written on the Compact Disc; even after a thousand copies thus a zero stays zero and one remains one[609]

- symbolic temporal order of "history" (i. e. almost time-invariant "tradition") differing from the entropic deterioriation of the electric charge and chemical carrier of the magnetic tape in real physics

- analog sound carrier, which is in-formed physical materiality, can still be identified according to the criteria of the historical method; digital signal transfer primarily is information in its communication engineering sense (given by Shannon), that is: unbound from energy and matter (as Norbert Wiener in his *Cybernetics* insists)

- really first recording of sound (in the media-archaeological sense) preserved as relic (in Droysen's sense "Überrest"), which is as un-intentional tradition (a Proustean *mémoire involontaire*, a Bergsonean "counter-archive" as defined by Paula Amad) originating from Léon-Scott's "Phonautograph" on a turning cylinder (the Kymograph as universal epistemological recording medium of 19th century), once invented not for purpose of replay or for transmission posterity, but just for immediate phonetic analysis (techno-linguistics)

- in media-active signal research, technological apparatus itself the archaologist proper. Patrick Feaster and David Giovannoni thus succeeded in re-sonifying the preserved phonautographic engravings ("Schallbilder"), beginning with Scott's recording of a sound folk tone of 435 Hz in the year 1859. 150 years later science realized that with optical "reading" of such acoustic signal lines sound can be re-synthesized, and all of the sudden a children's song sounds again. What metaphorically looks like the pick-up of sound images by a "virtual, digital gramophone

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[608] Siehe Wolfgang Hagen, Die Entropie der Photographie, in: Herta Wolf (Hg.), xxx

[609] Rudolf Taschner, Der Zahlen gigantische Schatten. Mathematik im Zeichen der Zeit, Wiesbaden (Vieweg) 3. Aufl. 2005, Anm. 77

needle"[610], in fact is something media-epistemologically different, a picking-up of a completely new kind: digital sampling.

Sonic arts / acoustic archaeology

- enunciations from an Edison wax cylinder, as once expressed by Michel Foucault in a slightly different context: "Message or bruit?"

- opto-digital reading of early Edison cylinders allowing for listenting again to otherwise unaccessible sound recording; the opto-digital *close reading* of sound as image, though, dissolves any meaningful unit into discrete blocks, which are accessible for human analysis only by operative techno-mathematical diagrams:

- "spectrogram of such a reconstructed acoustic recording as an analytic, media-archaeological deciphering

- the "media-archaeological ear", as an alternative to the cultural emphasis on musical semantics; installation by Yuri Suzuki at the Ars Electronica in Linz, September 2009, *The Physical Value of Sound*, explicitely based on the electro-mechanics of (manipulating) records (their speed) and pick-up systems (their non-linear use); www.yurisuzuki.com; micro-physical *close reading* of sound; dissolves any semantically meaningful archival unit into discrete blocks of signals instead of musicological hermeneutics; reminder of light-based sound inscription in early film

- to media-archaeologically sharpened perception, an animated figure on a computer screen will never be confused with a living being since such a mind is conscious of the algorithms of which such an animation is a technomathematical, processual function

- against the scarcity of instrumental artefacts and doubtful textual evidence from ancient music theory, anachronistic option of computational re-calculation of Aristoxenean arguments (dissertation Carlé)

The Vocoder

- advanced speech security system developed by Alan Turing in the Second World War, "Delilah"

- voice scrambling capabilities of the vocoder, known for its role in the history of electronic music rather than for its cryptologic potential

- SIGSALY 1943: matched pair of one-time-use vinyl records of random thermal noise, played synchrounsly. Sender: wrap spoken message in noise; receiver: filter

- Turing's *Delilah* for discrete voice encryption

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[610] Harald Haack, Die erste Klangaufzeichnung. Eine Audiografie, *online* http://newsbattery.blogsport.de/2008/05/07/die-erste-klangaufzeichnung-eine-audiografie

- Aleksandr Solzhenitsyn on his develpment of speech encipherment (approx. 1947-50) in his novel *The First Circle*

- "Extended Voices": Alvin Lucier's *North American Time Capsule* (1967): instructing performers of the Brandeis University Chamber Chorus to communicate Earth's present situation to beings from a faraway space or time by use of vocoder

- Kraftwerk's *Trans Europa Express* 1977 using Sennheiser VSM 201 Vocoder

- Vocoder runs the input speech through a series of bandpass filters, which measures the amount of energy in earch band and sends them as information, i. e. encoded; captures spectral information of the voice; receiver approximates it to the original voice

- Derek Holzer: http://tinyurl.com/probing-the-past-oldenburg; Holzer's installations "no re-enactment", but from the media-archaeological point of view, there is no historical context / distance. The coupling of the tone wheel and a photo-electric cell actually behaves the same 1930 and 2016

Un-natural: Artificial voices

- Wolfgang von Kempelen paradigm 1791: imitating human organs; still extension of men (Kapp / McLuhan), epistemologically different from genuine mathematical voice analysis / synthesis (Leonard Euler)

- 1819 Charles Cagniard de la Tour: two punched discs, one rotating; number of holes results in pitch; multiplied with rotation speed

- Hermann von Helmholtz 1863 *Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik* / vocal synthesizer

- 1939 Homer Dudley, world exposition New York, for Bell Laboratories: Voder = Voice Operation Demonstrator, manually directed, models physiological components byelectronic units: noise generator for voiceless phonems and sine tone generator for vowels; operator can control 10 band filters for modulation of signals, and generate pauses; pedals allows for pitch;

- generating sound / reverse: Welte-Mignon recording piano

- vocoder for multiplex telephoning and encryption = Voice Encoder / coding; analyzes incoming sound into frequency partials (Fourier), after transmission re-modulated by a noise signal

- Pattern Playback by Frank Cooper: synthesieses sound and speech by spectrograms

- by technical measuring of the human voice, it turns out in-human; most natural human articulation is revealed as completely un-naturally re-composable as artefact

- the natural itself can be given a "voice". A high-speed playback of an earthquake has been used by the seismological laboratory of the California Institute of Technology "as an input for a speech sonograph. The sonograph facilitates the study of transient effects" = Speeth: 909, note 5

- Mills 2010, 36: Built at the Bell Telephone Laboratories of American Telephone and Telegraph (AT&T), vocoder went beyond previous experiments with graphic inscription; revealed new ways for multiple messages to be passed down the same telephone wire, simultaneously; indicated that certain aspects of a vocalization could be subtracted without a listener perceiving any change. Speech could be broken into bits, much like “the subject” — which, Lacan had announced, “is no one. It is decomposed, in pieces. And it is jammed."[611]

- the act of hearing (within the human ears mechanism) *already* an analysis of the perceived sound waves into discrete impulses which become the impression of voice only by brain action (Hermann von Helmholtz insists)

- Dudleys "vocoder" different from the simple "voder"; voice became evident "comme diagramme du corps" (Catherine Paoletti) in the moment of spectrographic analysis

- with phonography not the symbolic order (music) was recordable but the sonicity of the oral poetry event: the acoustic signal, the micro-temporal variations

- Homer W. Dudley as electronic and acoustic engineer created the electronic voice synthesizer for Bell Labs (mostly in Bell Labs' Telephone Transmission Division) in the 1930s. More secretly, Dudley led the development of a method of sending secure voice transmissions during World War Two

- the uncanny in electronic engineering: something completely non-vocal, concretely a circuit of condensers and resistors, powered by electric current, can emulate human speech - thereby, in reverse, dis-covering the artificiality of human speech itself as spectrum event

- among Dudley's final projects: design of an electronic kit distributed by Bell Labs for home hobbyists and students, called *Speech Synthesis: an Experiment in Electronic Speech Production*; contained the components with which to create an electronic circuit that could produce three different speech formants

- Teuvo Kohonen's algorithmic experiment "with natural data" <Kohonen 1984: 148> which were collected in speech recognition in order "to visualize the topological or metric relations between phonemes picked up from continuous speech. "The inputs to the processing units consisted of spectra of natural speech, taken at 15 different frequency channels" <ibid.> - analogous to Vocoder analysis. One resulting SOM "shows at which processing unit each phonemic sample caused the maximum response" <ibid.>: Fig. 5.24a-b = Kohonen 1984: 148. In the self-organizing map (SOM), the sonic Wunderkammer returns - but in its contemporary form as an *operative diagram*

- processed by Markov chains, the human speech turns into similiarity-based dis/order, as applied to Friedrich Kittler's voice itself: [Audio] kittler-kov-Carle.mp3

- museological *Wunderkammer* premise indifferent to the ontologically emphatic distinction between art and nature, human and machine, live and animation, logocentristic presence and

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[611] Jacques Lacan, The Seminar of Jacques Lacan, Book II: The Ego in Freud’s Theory and in the Technique of Psychoanalysis, 1954 – 1955, ed. Jacques-Alain Miller, trans. Sylvana Tomaselli (New York: Norton, 1991), 54 (as quoted in Mills 2010: 36)

technical re-presencing (phonographic voices / synthesized sound)

- specific escalation of the "sonic Wunderkammer", no more dichotomy between natural and unnatural voices

- voices from tele-communication devices: irritations of "presence" / the present as the eqivalent of the visual / material Wunderkammer in the temporal domain of subjective time experience

- man most human when communicating in singing and speech, as defined by Aristotle and Wilhelm von Humboldt, Über Denken und Sprechen [MS 1995/96], in: W. v. H.l, Werke, ed. Albert Leitzmann, vol. 7,2, Berlin 1907 (reprint: Berlin (de Gruyter) 1968; man becomes inhuman if he can not tell the natural voice from the artificial Voder or Vocoder

- not "from" telephone (Alexander Bell 1976) "to" Vocoder (Dudley in the Bell Laboratories, patented 1939); rather immediacy; with Vocoder, human voice is only disembodied (the telephone, phonograph and radio experience), but by analysis into segments of its frequencies and transcoding for transmission becomes de-personalized (Christoph Borbach). From "he" or "she" to "it"; loss of the "grain of the voice" (Roland Barthes)

- individuality of voice, once coded for unrecognizable transmission, eliminated by Vocoder; noise instead

- "Dictionaries <...> may record a new item under *voice*: *voice terminal*, a computerized telephone. No longer, then, the illusion that the instrument transmits voice at a distance, carrying it unchanged over space and time; voice now passes through the circuits"[612] - and are therefore transduced from signals into computable numbers. "Receiver and sender are at their terminals, voice terminated. The end of the voice and the beginning of the terminal" <ibid.>.

- analogue telephony transduction of mechanical vibrations to voltage variations; vocoder symbolically transcodes it

- Helmut Holzer's spatial installation *Delilah Too Voice Encoder Project* at the "UnTune" exhibition of CTM Festival 2015 (Kunstraum Kreuzberg, February 2015) confronting the visitor with an acoustic *Wunderkammer*, since he participants experienced their own voice as complete alienation

- "Speech, to the telephone engineer, is a commodity that must be picked up in one place and delivered promptly, cheaply, and in good condition in another" = D. W. Farnsworth in "High-Speed Motion Pictures of the Human
Vocal Cords" (1940), as quoted in: Mara Mills, Deaf Jam. From Inscription to Reproduction to Information , in: Social Text 102 • Vol. 28, No. 1 • Spring 2010 , 35-58 (35)

- Mills 2010, 36, about the Vocoder: "Built at the Bell Telephone Laboratories of American Telephone and Telegraph (AT&T), this machine <...> revealed new ways for multiple messages to be passed down the same telephone wire, simultaneously. And, it indicated that certain aspects of a vocalization could be subtracted without a listener perceiving any change. Speech

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[612] Jonathan Goldberg, Voice Terminal Echo. Postmodernism and English Renaissance Texts, New York / London 1986, 1

could be broken into bits, much like “the subject” — which, Lacan had earlier announced, “is no one. It is decomposed, in pieces. And it is jammed.”4 " Note 4 = Jacques Lacan, The Seminar of Jacques Lacan, Book II: The Ego in Freud’s Theory and in the Technique of Psychoanalysis, 1954 – 1955, ed. Jacques-Alain Miller, trans. Sylvana Tomaselli (New York: Norton, 1991) , 54]

- once human voice itself became subject to spectrographic analysis, it turned out machinic (van Kempelen's effort / Homer Dudleys "vocoder" different from the simple "voder"). "Homer" Dudleys "Christian name" allows for a combinatorial reminder: The vocal alphabet - the adding of single letters to express single vowels AEIOU has been a "technological" (Ong) modification of the Phoenecean syllable alphabet - has been invented to write down HOMER's oral poetry in a quasi-phonographic way, to preserve the vocality of its articulation - grammo-phonic avant la lettre in the sense of "musical" letters. But only with phonography not only the symbolic order (music) was recordable but the sonicity of the oral poetry event: the acoustic signal, the micro-temporal variations

- Homer W. Dudley (1896–1987) as electronic and acoustic engineer created the first electronic voice synthesizer for Bell Labs (mostly in Bell Labs' Telephone Transmission Division) in the 1930s (at that time a division of Western Electric Company

- more secretly, Dudley led the development of a method of sending secure voice transmissions during World War Two

- *Wunder* in electronic engineering: that something completely non-vocal, concretely: a circuit of condensers and resistors, powered by electric current, can emulate human speech - thereby, in reverse, dis-covering the artificiality of human speech itself as spectrum event

- kit entered production in 1963, produced until the late 1960s; cp. Speak-and-Spell kit

"Frozen" voices

- printed texts necessarily excluding sound matter - even if, in a deeper sense, there is implicit sonicity in diagrams and graphs that are derived from sound sources. Media-archaeological purism resists the seduction to use substitute imagery instead; to what degree a sonagram (spectrum analysis) or sonogram (ultrasound-based visualization) keeps an indexical relation to the measured event; technologies to visualise sound and the human voice (in terms of signal recording and its spectrographical analysis); Mara Mills, Deaf Jam. From Inscription to Reproduction to Information, in: Social Text 102, vol. 28, No. 1 (Spring 2010), 35-58

- signal recording vs. techno-mathematical analysis / resynthesis in the media-archaeological, thus: techno-mathematical approach. Electronic synthesis of the human voice thus emerged: materially refined electronics (*techné*) and mathematical analysis (*lógos*). Boris Yankovsky's method of computing the human voice treats sound matter in a fully formal approach. A combination of a mathematical model of the synthetic tone ("syntone") and its implementation in a processing mechanism (Vibroexponator) turns the symbolical abstraction into a media event in physical time. In order to get to the essence of sonic articulation, a suspense from any imagination of sound has first to take place - operative sonicity: "To synthesize the human voice singing a vowel, one would need to choose several templates related to formants (drawn waveforms [...]), to add extra templates as needed [...], to recalculate their sizes according to the desirable frequencies and intensities of formants, and then to mix them. The final

waveform would sound like a 'frozen' vowel. This waveform could be used to produce a temporal 'quant' of sound, physically related to one frame of the film. To produce the sound, dynamically changing in time, one would have to calculate the sequence of static frames, in which each frame represents the successive state of changing timbre."[613]

"Harmonizing" voices by sampling

- phonograph, gramophone and magnetic recording "incapable of achieving real-time frequency shifts. For this we need rock bands with harmonizers that are able to reverse—with considerable electronic effort - the inevitable speed changes, at least to deceivable human ears" = Friedrich A. Kittler, Gramophone, Film, Typewriter (1986) trans. Geoffrey Winthrop-Young and Michael Wutz, Stanford (Stanford University Press, 1999, 35; pitch shifter (Harmonizer) *transposes* male voices into female ones *in real-time* indeed, by computationally recalculating the frequencies

"Cold" speech synthesis

- in telephony, acoustic signal "heats up" the human sensual perception (McLuhan); its mathematical analysis cools it down; media-archaeological, that is: techno-mathematical approach such as the electronic synthesis of the human voice which takes place as a coupling of materially refined electronics (*techné*) and mathematical analysis (*lógos*)

- truly techno-epistemic approach to modeling the human voice not imitating the organic human vocal tract by mechanical analogies but analyses the voice as signal event and wave form itself. Once techno-mathematically analyzed (like with von Helmholtz' "Resonators"), the complex sonic colour can be composed from single sine waves. When Boris Yankovsky in the 1930s founded his Syntonfilm Laboratory in Moscow it was based on his media-operative insight into the genuinely time-critical nature of sound waveforms as temporal transitions; detected "life inside the sound spectrum"[614]. The mathematical approach and "graphic sound" of a non-metaphorical kind - sonagrams as the diagramatic expression of dynamic development of the sound spectrum in time - uncover the layers of sonicity. Sound could be analysed and represented as the Fourier series of periodic functions - and consequently be re-synthesized back with the same set of sine waves[615]; Yankovsky treating the human voice in a

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[613] Smirnov 2012: 215, referring to an unpublished manuscript by Boris Yankovsky, teorya i praktika graficheskogo zvuka. Akusticheskiy sintez muzikalnih krasok [The Theory and Practice of Graphical Sound. Acoustical Syntheses of Musical Colours], Leningrad (between 1932 and 1940), in the Archives of the Teremin Center, Moskow. See Andrey Smirnov, Synthesized Voices of the Revolutionary Utopia, in: Dmitri Zakharine / Nils Meise (eds.), Electrified Voices, Konstanz (V&R unipress) 2012, 163-185

[614] Boris Yankovsky, Analiz i sintez tembra, unpublished article Moscow, March 1935; quote and translation: Andrey Smirnov, Sound in Z. Experiments in Sound and Electronic Music in early 20th Century Russia, London (Koenig Books) 2013, 209

[615] Boris Yankovsky, Teorya i praktika graficheskogo zvuka. Akusticheskiy sintez muzikalnih krasok [The Theory and Practice of Graphical Sound. Acoustical Syntheses of Musical Colours], Leningrad (between 1932 and 1940), in the Archives of the Teremin Center, Moskow, as quoted and translated by Smirnov 2012: 210

fully formal approach

- combination of a mathematical model of the synthetic tone ("syntone") and its implementation in a processing mechanism (Yankovsky's "Vibroexponator") turns the symbolical abstraction into a media operation which takes place in actual physical time

- to get to the essence of sonic articulation and to synthesize the human voice singing a vowel, a suspense from any semantically hot imagination of sound has to take place, a cooling by analysis: "The final waveform would sound like a 'frozen' vowel"[616]

- cultural recording as symbolical operation; current digital code returning to first expressions of pre-Grecian writing which have been invented for *calculating* purposes[617] - now calculating on the level of digital signal processing with a precision in reproduction which emulates the natural signal itself (due to the Nyquist / Shannon sampling theorem). Fourier Analysis allows for the mathematical transformation of a temporal function or sequence of signals into a spectrogramm; Fast Fourier Transformation as analytic operation performed by the computer itself when translating a recorded voice event into a mathematical regime, thus allowing for a kind of cultural analysis in ways which only computing can do. At that moment, the machine is the better media-archaeologist than any human. Only by application of such technological tools can we explain the micro-temporal level of such events. Computer-based Fast Fourier Analysis gives access to another worldliness of a cultural moment. Consequently,book cover on the origins of the vocal alphabet (W. E. / Friedrich Kittler (eds.), Die Geburt des Vokalalphabets aus dem Geist der Poesie. Schrift - Ton - Zahl im Medienverbund, Munich (Fink) 2006) shows both an image of one of the first Greek alphabetic inscriptions (remarkably in hexametric diction) *and* the spectrogram of the same verse line read and spoken by Barry Powell: see Barry Powell, Homer and the Origin of the Greek Alphabet, Cambridge (UP) 1991

A different kind of recording: The phonographic un-archive

- sound and speech most “immaterial” cultural articulation (before the electronic age); phonographically recorded acoustic real "forms the waste or residue that neither the mirror of the imaginary nor the grid of the symbolic can catch: the physiological accidents and stochastic disorder of bodies"[618]

- *digital* audio recording *integrating* the vibrational "calculation" of sound, close to the Turing Machine states and chrono-photographical sequences of stills than to analog phonography; Alan Turing's paper "On Computable Numbers" 1936 reconciliated real numbers with the symbolical machine

- BBC World Service launched the "Save our Sounds" project, may soon be lost due to the post-industrial world. But caution, this is not an archive: As long as an algorithm is missing which rules the transition of sound provenience to permanent storage, it is just an ideosyncratic random collection

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[616] Smirnov 2012: 215, referring to Boris Yankovsky's "Theory and Practice of Graphical Sound"

[617] See Denise Schmandt-Besserat, Before Writing, vol. I: From Counting to Cuneiform, Austin (University of Texas Press) 1992

[618] Kittler 1999: 15 f.

- musical notation (developed by Greeks and Guido of Arezzo in analogy to the alphabet) still symbolic recording; phonograph registering the physically real signal. While alphabetic symbolism reduces acoustic events to the "musical" (harmonical) order, the register of the acoustic real encompasses the whole range of the sonic (including noise and arhythmical temporal phase shifting such as "swing" and differing amplitudes / frequencies

- due to the limits of hermeneutics as text-oriented method, and because of an essential lack of non-symbolic recording media of the real; not just providing historical research with a new kind of source material; it rather articulated new, rather ahistorical forms of tempor(e)ality on the level of the physically and mathematically real (techno-logy)

- muscial scores usually ending in paper archives, not on gramophone records. "Notation wants music to be forgotten, in order to fix it and to cast it into identical reproduction, namely the objectivation of the gesture, which for all music of barbarian cultures martyrs the eardrum of the listener. The eternization of music through notation contains a deadly moment: what it captures becomes irrevocable ... Musical notation <...> is about eternity: it kills music as a natural phenomenon in order to conserve it — once it is broken — as a spiritual entity: The survival of music in its persistence presupposes the killing of its here and now [...]"[619]

- with the phonograph, hearing became attentive of all kinds of sounds, regardless of their source, quality and meaning(lessness), just like the inner ear impassionately transduces vibrations analogue to electro-mechanical sound reproduction[620]; listening became ahistorical, subject to the time-invariant reproducibility of acoustic signals; a tone exists only in transience, that is: as Husserlean "time-object"[621]

- technical media archaeologists themselves: measuring instruments which are able to decipher physically real signals techno-analogically, and representing them in graphic forms alternative to alphabetic writing: „moving“ diagrams, as performed by the oscilloscope

Remembering past sonospheres by technical media

- http://strangeattractor.co.uk/shoppe/rorschach-audio/ http://rorschachaudio.wordpress.com. Trade distribution by Turnaround Art Theory, Cultural Studies. An early MIT Press version of "Rorschach Audio" published 2001

- with the refinement of the Phenician alphabet to the Greek phonetic alphabet (which Ong actually called a "technologizing of the word"[622]), acoustic articulation (speech, singing, oral poetry) symbolically recordable for re-play; presence-generating power of technically recorded

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[619] Theodor W. Adorno, Zu einer Theorie der musikalischen Reproduktion, Frankfurt/M. (Suhrkamp) 2001, as quoted by G. Mazzola, Musical performance. Springer, Heidelberg 2010

[620] Jonathan Sterne 2003: 33

[621] See Edmund Husserl, The Phenomenology of Internal Time Consciousness, trans. James Churchill, Bloomington, Ind. (Indiana University Press) 1964

[622] Walter Ong, Oralität und Literalität. Die Technologisierung des Wortes, Opladen (Westdt. Verl.) 1987

voices differs fundamentally from the *grama*-phonic notation of speech in the vocal alphabet

- "Discourse analysis cannot be applied to sound archives or towers of film rolls"[623]

- "Hearing the cracks and noises of a phonograph recording may initially enlighten their historical status as 'mechanical' instruments."[624] In terms of the mathematical theory of communication (Shannon 1948), such cracks belong to the kind of "noise" introduced by the channel of transmission itself which is here: the channel called time

- media archaeology starting here: phonograph as media artefact not only preserving the memory of cultural semantics but "archivizes" past *technical* knowledge as well, a kind of frozen media knowldege embodied in engineering and waiting to be un-revealed by media-archaeological consciousness

- "Listening to Technology"[625] as *close listening* to the technological artefact itself. The Museum of Endangered Sounds takes care of the sound of "dead media"[626], and the Technical Committee of IASA in its recommendations from December 2005 insists that the originally intended signal is just one part of an archival audio record; accidental artefacts like noise and distortion are part of it as well - be it because of faults in the recording process itself or as a result of later damage caused in transmission; both kind of signals, the semantic and the Proustean *mémoire involontaire*, message *and* noise, be preserved in media-archival conservation ethics; media-archaeological listening to the *sonic* past rather about listening to the technical signifier than to the acoustic or musical content

- with digital sampling and processing of audio-signals, noise resulting from the frictions of analog technologies is significantly filtered, thus: silenced; former noise replaced by an even more endangering challenge: the "quantizing noise" on the very bit-critical (technical) level of signal sampling, and the migration problems of digitally compressed media data; physical vulnerability of electronic storage media; not just a technical question, it has an epistemological dimension as well[627]

Is there a "sound of the archive"? Listening to silence with media-archaeological ears

- software for sound analysis *Audacity* actually providing an algorithm called "Silence Finder". In the negative sound, its silence, we listen to the past in its truest articulation

- not only implicit (sonicistic) but as well actual sound from the media-archaeological archive;

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[623] Friedrich Kittler, Gramophone - Film - Typrewriter, Stanford (UP) 1999, 5

[624] Karin Bijsterveld, Mechanical Sound. Technology, culture, and Public Problems of Noise in the Twentieth Century, Cambridge, Mass. / London (The MIT Press) 2008, 26

[625] See Bijsterveld 2008, chap. 1

[626] See the Website „Museum of Endangered Sounds“, *online* http://savethesounds.info

[627] See Arild Fetveit, Medium-Specific Noise, in: Liv Hausken (ed.), 189-215

when an ancient "Datassette" loaded from external tape memory into the ROM of a Commodore 64 computer, actual to data music: not sound as memory content like an old persussion-assisted song, but rather the sound of computer memory itself, that is: a software program which is "scripture" (though in the alphanumeric mode); Ben Anderson, Recorded music and practices of remembering, in: Social and Cultural Geography, vol. 5, No. 1, March 2004, 3-19; listening to the data archive which is not sonic memory but sonicity

- silence re-interpreted as an enduring negation of time-based sound, as performed in John Cage's piece *4'33*.[628]

- Edison phonograph the first form of "memory in motion", since its "records" (notably the early ethnographic field recordings around 1900, institutionalized as the Vienna Phonograph Archive and the Berlin Phonogramm Archive) is based on a continuously rotating, technically moving apparatus both in recording and in re-play

Material entropy of the signal *versus* symbolic (archival) endurance of sound recording

- Bill Viola's essay on the implicit *sound* of electronic images; "the current shift from analogue's sequential waves to digital's recombinant codes" in technology.[629] Sampling and quantizing of acoustic signals analytically transforms the time signal into the information of frequencies which is the condition for technical re-synthesis (Fourier transformation). Digitalization means a radical transformation in the ontology of the sound record - from the physical signal to a matrix (chart, list) of its numerical values. Media culture turns from phonocentrism to mathematics

- the techno-mathematical *archive*; transfer techniques of audio carriers from technically extended "writing" such as analog phonography to calculation (digization), not just another version of the materialities of tradition, but conceptual change; basically atemporal dimension. Against the noise of the real culture (especially techno-logical, that is: „digital“ culture) poses a negentropic insistance, a negation of decay and passing-away

- digital copies of digital records produced almost without loss of data (except the quantization noise). Music on Compact Disc or a digitale video can be reproduced frequently with stable quality which was utopean in recent times of analoge recording on magnetic tape. The secret of this temporal unvulnerability is that it is just (physical representations of) numbers which are written on the Compact Disc; even after a thousand copies thus a zero stays zero and one remains one[630]

- past sound not just "restored" by applying digital filters; rather wants to be remembered with all the traces of decay which has been part of its tradition, its media-temporal (entropic) characteristics must be archivized as well; remain close to the physical record which is

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[628] On the occasions which led to this composition see Seth Kim-Cohen, In the Blink of an Ear, New York (Continuum) 2009, 160ff

[629] Viola 1990: 47

[630] Rudolf Taschner, Der Zahlen gigantische Schatten. Mathematik im Zeichen der Zeit, Wiesbaden (Vieweg) 3. Aufl. 2005, note 77

achieved by over-sampling; stay tuned to such non-archival sonicity

On "sonicity"

- electronically-generated high frequency oscillations' (electromagnetic waves) under the media-archaeological gaze understood in their operative micro-temporality; main principle in all oscillators "a tension between *opposing forces* combined with a regenerative or *positive feedback*"[631]

- sonagrams a process by which imperceptible sonic articulations are rendered accessible to human senses as visual data by a process of transduction and pixelization; radar's visualization of sonic data a similar mode of processing. While technical media like the gramophone store sound for replay, electronic media store implicit sonicity as information. 'Any electronic instrument electromagnetically transubstantiates the essence of sound from mechanical vibration into an essentially different, but physically analog form of existence, from explicit sound to implicit sonicity; when digitized, temporal articulations of the real become implicit information of the symbolic, available for digital re-call via computational "algorhythmics" = Shintaro Miyazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012 (http://computationalculture.net)

- a "sense of ending"; when pick-up of the record player put into the vinyl groove, the spiral writing of the groove itself is already the starting of its own end; music, once recorded on a sonic time object, has an in-built sense of ending, different from geometrical existence as score; vs. ideal "timeless" Fourier analysis of the sonic signal

- "technical media are media of non-solid, non-phenomenological worlds (electro-magnetic fields, high-level mathematics, speeds beyond human comprehension" = chapter "Non-human media", in: Jussi Parikka, What is Media Archaeology?, Cambridge / Cambridge, Mass. (Polity Press) 2012, 55-61 (62)

Matter sounds: Acoustic earthquake monitoring

- recording for subsequent analysis of otherwise ephemeral vibration; for implicit sonicity to be articulated acoustically, it has to be inscribed in solid matter; functional sonification a major practice to detect sudden changes in monitoring earthquakes; *matter sounds*: "By time-compressing the output of a seismometer, it is possible to present seismographic data in an auditory display."[632] With the time-critical capacity of human hearing, it is thus possible "that the seismic sounds due to natural earthquakes may be distinguishable from those due to underground explosions"; "the ear's ability to use the information contained in the temporal dynamics of the short-time audio spectrum" = Speeth 909. Remarkably, though, in order to perform such literally distinctive analysis, "[a] pair of seismograms, one of an explosion, the other of an earthquake, <...> had been digitalized <sic> at a sampling rate of ten samples/sec., and were available on punched cards. To equalize intensities, the two sets of

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[631] György Buzsáki, Rhythms of the Brain, New York (Oxford UP) 2006, 142

[632] Sheridan Dauster Speeth, Seismometer Sounds, in: The Journal of the Acoustical Society of America, vol. 33, number 7 (July, 1961), 909-916 (abstract)

cards were fed into an IBM 7090 where every sample of one set was multiplied by a constant to produce equal rms amplitudes. Both were then read onto a magnetic tape through a digital-analog converter at sampling rates of 1000, 2000, 4000, and 8000 samples/sec. This provided time compression factors of 100, 200, 400, and 800. The resulting analog tape was played was played through an AR-1 loudspeaker, and a clearly discriminable difference between the two seismograms could be heard" = 909 - thereby resulting in a "audio tape" of a second, implicitely sonic quality ("soncity"). A similar high-speed playback of an earthquake has been used by the seismological laboratory of the California Institue of Technology "as an input for a speech sonograph to facilitate "the study of transient effects"[633]

"Post-digital" nostalgia for sound matter? On *Untitled II*

- discovery of electro-acoustics, mechanically sounding body no longer conditional, de-coupling the sonic event from matter; pick-up of an electric guitarre transducing material vibrations of the string into almost immaterial electro-magnetic induction (even if, in addition, there is still a sublime effect of the wooden block for material resonance: friction, dissipation). Within the technical medium, sound becomes a pure signal, subject to analysis, transformation, and synthesis. "In the digital age, sound finally became fully autonomous: As a pure stream of information it is now amenable to any kind of algorithmic manipulation "without the involvement of a sounding body in the conventional sense" = CTM 2015 "Un Tune" (draft)

- for an algorithm to unfold, a strict sequential order mandatory (be it linear, or loops, or conditional jumps like "GOTO" order in BASIC); turingmachine as such not time-critical; its numerical (digital) pulse sequences take place stepwise, counting; a more metronomic time-base (duration of each step, cycling units, speed, technological "prosody") only takes shape when such a "score" is actually implemented into a computing machinery, becoming "algorhythmicized" (Miyazaki)

- "post-digital" art re-injecting bodily and other matter back into electronic sound; re-sonification: media-artistic slowing down high-frequency medium operations to make them accessible to human (sonic) perception again (like early digital computing still audible); media archaeology as decisive "archaization" / slowing down in the temporal domain; rather chronophotography than the cinematographical illusion of continuous movements

- primary component of an electro-acoustic synthesizer, the “oscillator”, connecting electronic components in a feedback loop; LCR circuit containing capacitor, coil and resistor

Fourier('s) implicitely "sonic" analysis of heat conduction and its cold calculation

- techno-mathematical operation of Fourier Analysis transforming the time domain of the sonic wave form into the frequency domain; a given function represented by a series of sinusoidal functions; Fourier transform "decomposes a function of time (a signal) into the frequencies that make it up, in a way similar to how a musical chord can be expressed as the frequencies (or pitches) of its constituent notes" = https://en.wikipedia.org/wiki/Fourier_transform, accessed August 30, 2017

[633] Speeth, 909, note 5

- implicit sonicity in all Fourier Transformation, even though in Fourier's original publication (1822) on heat conduction, such mathematical analysis applied to other vibrational and oscillatory events only marginally; decompose complex (but periodic) functions like what is perceived as sound into the sum of simple (sine and cosine) waves which - in reverse - can be expressed (and thus: computatinally addressed) as frequency, i. e.: numbers; sound as addition of tones; drone = "Ge/Summe" (both as kymatically and mathematically)

- by Fast Fourier Transformation, any kind of (digitized) sound broken down into discrete time slices, shunks of sound / Gabor's "acoustic quanta"

- "Ces considérations offrent un example singulier des rapports qui existent entre la science abstraite des nombres et les causes naturelles" = Jean-Babtiste Joseph Fourier, Théorie Analytique de la Chaleur, Paris (Firmin Didot) 1822, 15; Fourier derives a general conclusion: "Plusiers questions de mécanique présentent des résultats analogues, tels que l'isochronisme des oscillations, la rèsonnance multiple des corps sonores" (ibid.)

- Nyquist/Shannon sampling theoreme betraying the natural (physical) criterium of indexicality, proving that (at least for the range of human sensual perception) a continuous signal can be quantized and time-discretely be digitized and still be reconstructed without loss of *information* when this is done with a frequency at least doubling the highest frequency contained within the signal

- Fourier's mathematical insight into dynamical processes anticipated by Leibniz' concept of the unconsciously calculating ear; implicitely sonic

- Hermann von Helmholtz rhetorically questioning if Fourier's analysis might not be a "mathematical fiction"[634] - "[...] bloß eine mathematische Fiktion, welche zur Erleichtung der Rechnung erlaubt sein mag, aber nicht notwendig irgend einen entsprechenden reellen Sinn zu haben braucht?"; human ear actually performing a mathematical analysis of complex sound into its frequency components itself

- vibrating electrons, atoms and molecules the cause for energy conduction within and between adjacent bodies; appropriately, quanta of thermic wave energy within crystals called *phonons* = entry "Thermal conduction" in the online encyclopedia Wikipedia, accessed September 27, 2013

Paris (Schaeffer) vs. Cologne (Stockhausen): Body-performative electro-mechanical kinetics vs. circuitry-operative electronics

- sono-epistemological conflict between Paris studio of *musique concrète* (Pierre Schaeffer) and the Cologne WDR radio of Electronic Music (created by Herbert von Einem): recording and manipulation of originally physical sound *versus* electronic sound generated by tone oscillators from the beginning, in pure sonicity

- Pierre Schaeffer operating with recorded sound and noise from natural surrounding, *la musique concrète*, by means of the recording device of the magnetic tape, cut into new

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[634] Hermann von Helmholtz, Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik, Braunschweig (Vieweg) [*1863]; 6th edition 1913, 58

combinations; *Studio für elektronische Musik* established under direction of Herbert Eimert in 1953 at the Cologne broadcasting radio station, where sound has been originally generated by electronic devices (literally "synthecised"), based not on musical harmonics, but on pure sine wave, on serial aesthetics, statistic probabilities, mathematical stochastics ("sound" in media-archaeological listening)[635]

- Schaeffer's *Phonogene* (like his *Morphogene*) continuous like phonograph; "sons animés" as Duchampean concept of "found objects", Pierre Schaeffer, Traité des objets musicaux, different form "objet sonore"; in electronics (instead of simply "electrics"), term derives from the triode, undoing all mechanical hindrance; no kinetic but cybernetic coupling as electric circuitry, electro-magnetic inducting happening withpout bodily intervention which is still cultural technology. machine music vs. elecronic music (Meyer-Eppler). Schaeffer: performative electro-mechanism; Cologne studio: operative by machines. still "hands on instrument" in cologne, but in the cybernetic sense of directing (Steuerung), not: direct sound production by physical energy. Electrons in thermionic tube have no mechanical energy, rather: intelligent control of voltage like in synthesizer. kinetic = body techniques in soud nproduction, vs. full techno-logcy. if kinetics, then in the sense of Reuleaux / babbage: coupling. as long as human hands tinker with technology, this is "soft" media-archaeological experimentation (exploring the machine); Brian Kane, "Twilight of the Sound Object", conference *Sound Art Matters*, University of Aarhus, June 1-4

Sonic memory's two technological embodiments: physical signal and archival symbol

- in micro-physical *close listening*, the materiality of the recording medium itself becomes poetical

- Bill Viola on "the current shift from analogue's sequential waves to digital's recombinant codes" in technology.[636] Sampling and quantizing of acoustic signals analytically transforms the time signal into the information of frequencies which is the condition for technical re-synthesis (Fourier transformation). Digitalization means a radical transformation in the ontology of the sound record - from physical signal listening to a listing of its numerical values; media culture turns from phonocentrism to mathematics again

- difference between audification and sonification and musification; first one is the "archaeological" layer (acoustics of "the real"), sonification is already a symbolical representation and musification represents the imaginary (the semantic); ears as reverberative micro-wave emitters sonificators themselves

- "sound" from a CD player nothing but a sonification of a serial array of binary data, that is: square-shaped signals; symbolisation in form of bits, while being an abstraction from the real world, does not mean that the relation between the information and the physical world has become purely arbitrary. When analog signals from the physical world are being sampled (i. e. time- and value-discretely quantized), the resulting strings of bits ("words") as still quasi-indexically shaped by the original physical event which, in the case of digital visual recording of dance, is the moving bodies

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[635] See Friedrich Knilli, Das Hörspiel, Stuttgart (Kohlhammer) 1961, 30 f.

[636] Viola 1990: 47

- occidental musical theory dominated by Pythagorean epistemology: music not the sonic event in itself but a phenomenon of integer mathematics, thus: symbolic regime; sound as mathematics *in operativity*, that is: implemented into vibrating matter

- Technical Committee of the International Association of Sound Archives in its standard recommendations for archival sound recording in December 2005: relative to technological changes of conditions[637]; digital data need constant up-dating and „migration“ (in terms of emulating hardware to run them); conceptual shift from the frozen archive to permanent re-implementation

Sonic memory: Electronics makes a difference

- digital recording representing fundamentally different materialities and logics (techo/logies) in terms of their ways of registering time-variant signals, time-based forms of reproduction and their "archival" being in time; electronic tube, especially the triode, once liberating technical media from mechanical constrains, thus: from erasure over time; still the tube or transistor are subject to decay over time themselves

Material entropy *versus* symbolic endurance of sound recording

- with refinement of the Phenician alphabet to the Greek phonetic alphabet[638], acoustic articulation (speech, singing, oral poetry) became symbolically „recordable“ (coded) for space- and time-independent re-performance (de-coding)

- „archival“ permanence of recorded sound signals almost invariant towards change with time („absconding from history“, as expressed by Rainer Bayreuther), leading to ahistorical immediacy in the moment of re-play; physical reality of storage devices over time: increasingly subject to macro-temporal entropy such as the material deteriorisation of Edison cylinders or magnetic tapes. Digitized signals at first sight represent the re-turn of traditional music notation (the score), but this time the symbols („bits“) are endowed with operational activity; they are algorithmically executable

Media "music"

- source code / poetry working as well when just reading it (even silently) – the success of the phonetic alphabetic recording / of mnemonic or high level programming; musical score depending on its actual sonic realisation in its physical sound bodies = Hammerstein 1866: 2, respectively its „hardware“; algorithms become operative only when implemented in matter, being in the world, thus: in time

- music-as-theory belonging primarily to the symbolical order (notation / concept. As such music is invariant against entropic time, different from the incorporated sound whose physicality is time-bound indeed (the "real"). "Being in music <...> is conceiveable only as an

[637] See http://www.iasa-web.org/IASA TC03/IASA TC03.pdf (accessed June 2011)

[638] See Barry Powell, Homer and the Origin of Writing, xxx 1991

'enclave'" = Erlmann 326, paraphrasing Stern

- media and music both coming into being only in performance; „musical situation“ (Stern) and the definition of technical media, coming into existence only in the process of performance („Vollzug“); temporal experience of listening to music is „faktischer Mittvollzug der Bewegungen“, a „Mitgehen“ = TS 1930: 66

- since emergence of signal recording devices like Léon-Scott's Phonautograph or Edison's Phonograph, an acoustic event can be re-played invariant towards historical change; „phonographic situation“ (term coined in accordance with Stern) a temporal ecstasy, "off" historical time. What the transposer does to pitches and voices, the phonograph does to acoustic time[639]

- gramophone disc, according to Stern <as quoted in Ellensohn 2008: 64>, does not reveal an acoustic image of the *Mondscheinsonate*, but the *Mondscheinsonate* itself - just like the radio does not reproduce speech and music, but actually displays them

- "[T]he *sine qua non* of writing the history of past music is to have this past music *re-enacted in the present*" = Collingwood's 1928 lecture "Outlines of a Philosophy of History", in: Collingwood 1946/1993: 441; equivalent to time-signal based technologies

Symbolic notation: invariant against historic, i. e. entropic time

- Isidor from Sevilla: „Nisi enim ab homine memoria teneantur soni, pereant, quia scribi non possunt“ = quoted in Hammerstein 1966: 4 - until the arrival of Guido of Arezzos notation of musical duration (symbolically) and the phonograph (signal-really) allowed for fixing sonic articulation / phonography

- in replay of an ancient phonographic record, *the audible past* (Jonathan Sterne) rather articulates itself in the noise of the recording device (the ancient wax cylinder) than the recorded voice or music; the medium talking both on the level of enunciation and of reference. What is heard most: the cultural content (the formerly recorded songs) or the medium massage such as limitations in vocal bandwith, even noise (the wax cylinder scratch and groove)?

- tempor(e)ality of technical media grounding in the entropic deterioriation of the electric charge and chemical carrier of the magnetic tape *versus* symbolical, i. e. almost time-invariant „tradition“

- an archival record suspended from historical respectively entropical time? traditional archival endurance of records, based on the very materiality of its carriers (storage media), changes its nature from endurance to the „enduring ephemeral“ (Wendy Chun) when the record is not fixed any more on a permanent storage medium but takes places electronically; flow (the dynamic essense of electric current) replaces the inscription

Re-entry of "music" as symbolic form: computing

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[639] See Stern 1930: 59, Anm. 1, on "Transponierung"

- *musical* memory symbolically notated in scores, while *sonic* memory preserved in signal-based phonograph recordings, endowed with "temporal indexicality"

- different from the age of handwritten and printed textuality, electronically stored signals (French *écriture magnetique*) themselves become ephemeral like sonic or vocal articulation in previous times. "Although digital information is theoretically invulnerable to the ravages of time, the physical media on which it is stored are far from eternal"[640]

- in computational media, alliance between computing (algorithm) and *mousiké* (rhythms) implicitely returns; sonicity "matters" not as actually acoustic, but processual event; "implicit sonicity" refers to sound not as an audible phenenomenon but its "message" as time-signal

Abuses of "sound" for computer graphics

- vector graphics (for early computer games) as "abuse" of audio-*Ausgang* of PCs (since the only analog interface, where from bit values *Spannungen* can be generated), to direct cathode ray beam in vector monitors = communication Stefan Höltgen, 23 January 2015

- hybrid inbetween: "Digital Vector Generator" (DVG) as internal chip between digital computer and vector screen (addressed by Opcodes)

- term "Rasterbildschirm" *Ansteuerungsmodus* of Cathode Ray Tube electro-physical essence irreducibly remains "analog", different from the genuine pixel screen; hybrid: vector games output on raster screen (with smoothing Besenham algorithm for Anti-Aliasing of scalar effects)

Listening (to) radio transitively and nuclear "radio"

- only graphical representations of the sound wave allowing to be analysed and represented as the Fourier series of periodic functions (sine waves); in reverse: synthetic acoustics?" = Boris Yankovsky, The Theory and Practice of Graphical Sound, as quoted and translated by Smirnov 2012: 210

- transition of discrete pulse trains into an impression of continuous waves implicitely sonic (and becomes audible by attaching a loudspeaker: Philips LOCMOS (Local Oxidation Complementary Metal-Oxide Semiconductor) Blinker; an essential emanation of electronics itself, the perceptible effect being a direct function of operative media-diagrammatics. The technical impulse diagram reveals the coming-into-existence of this electro-rhythmic sequentiality with the kinematoscopic effect of a circulating waveform; discrete pulses generated by a symmetric astabile multivibrator with a fixed frequency are combined with a calculated system of delays, time-defined by capacitors and resistors, differentiating the current at the exit of inverters

- with the "resonant circuit", radio suddenly becomes the "sonification" of an *implicit* "syntony" (David Lodge); Aitken 1976; archaeological investigation close to engineers' signal analysis of

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[640] Jeff Rothenberg, Ensuring the Longevity of Digital Documents, in: Scientific American, Vol. 272, No. 1 (January 1995), 42-47 (42)

physical media

- uncover (*aletheia*) the hidden agenda of technomathematical artefacts, or artefactuality, media not only on their structural but on their *operative* level. Heidegger never opened his radio; radio has been synecdochically disguised. Radio means the circular propagation of electromagnetic waves (thus "broadcast"). One special form of signal transmission, short wave radio, operates on the basis of reflection of radio signals in the ionosphere (literally "between heaven and earth"); the well-known effects like "fading" in listening to Short Wave is transitive listening to the instant ionospheric "weather" report (communication of seasonal Ionospheric "weather forecast" in Amateuer Radio journals)

- "It's more typical to speak of visible light as wavelengths measured in nanometers or angstroms. I'm using frequency to be consistent with sound. They're equivalent, as frequency is just the inverse of wavelength" = „24/192 Music Downloads ...and why they make no sense“, Autor: „Monty“, 1st March 2012 = http://people.xiph.org/~xiphmont/demo/neil-young.html; accessed March 2012

- case of radio-active deposits, we are not dealing with immobile materiality or passive symbolic codes, but with matter which is emits signals actively. Nuclear waste, by definition, is "radio" active; so why not take the radiation itself as basis for continuous signalling? "Every form of physical energy propagation can be used as a channel for conveing messages" = Sebeok 1985: 459; sonification an option of indicating the degree of radio-active decay itself - and not just "acoustically" coded images as in the case of the Voyager disc or acoustic records from noises, sound and ethno-music recorded on earth

"Immaterial" sonic heritage? Archaeo-acustics

- UNESCO caring for the preservation of *immaterial* heritage of ephermal cultural articulation like speech, dance, music, and computer software. The ephemeral is what the traditional museum can not preserve; preservation of processual techno-logical knowledge like computer software (Doron Swade)

- mediatempor(e)al specificity of "acoustic space" (McLuhan) as opposed to the geometricized space of the Gutenberg print era. On the other hand the "deep" time of archaeoacoustics (a term coined by Scarre and Lawson 2006) which - still - is radically present whenever it is measured and re-enacted. Any sonic articulation can not be past and is by definition ahistoric (different from "music" which belong to the symbolic regime, i. e.: historiography;no wave-based model of acoustics in antiquity = Devereux ibid., inhibited by symbolical regime of "musical" order

- archaeoacoustics by modern performance of music at ancient sites; investigative research "using monitoring with *electronic* instrumentation" = Paul Devereux, Sound & Ancient Sacred Places, in: UN TUNE. CTM - Festival for Adventurous Music & Art, 16th Edition, Berlin 2015, such as sound generation (wide frequency "pink noise"), and studying acoustic resonance inside acoustic spaces; sirenic research

- resonance frequency detected *by measurement* in several prehistoric monuments in England and Ireland focused on 110 Hz, equals the lower baritone register of the human voice =

Devereux & Jahn 1996; effects on the human brain activity[641]; past can be made to "speak"[642]

Tuning into the past

- "In technical terms, 'tuning' is the process of getting into a certain state of resonance, and in electronics is related to so-called 'tuned circuits'."[643] Tuning thus involves circuitry. In order to get reception the circuitry of a radio receiver needs to oscillate with the same frequencs as the radio sender's carrier frequency

- epistemological equiprimordiality: "Electric oscillations as well bioelectric signals and acoustic vibrations are equal in mathematical terms, and can all be describe by using equivalent curcuit diagrams. Moving from acoustics to elecronics was thus merely an act of algebraic translation."[644]; term "sonicity" meant to catch this co-originary analogy - and to name sound which not only became silenced (like the "Funkstille" in German militäry radio at the end of World War II), but to name "inaudible operativity" = Miyazaki 2015: 67, as such like radio carrier waves which are active even when there is no low-frequency modulation by voice or musical waves at all; preface to Barkhausen, *Schwingungslehre*

- sound from / in the past not overall ephemeral but coupled to matter from which is originates physically or electronically. Rather than just extending variety of "historical sources" by sonic dimension, sonic media have a proper temporality themselves. "ideo-sound" refers to the aging of media materialities, such as the "pre-echo of magnetic tape that has long gone unheard", up to "the crackles and pops of scratched vinyl" or "the skipping of a CD" = Jens Gerrit Papenburg, (Re-)Mastering Sonic Media History (typescript January 2015), published version in: same author / Holger Schulze (eds.), Sound as Popular Culture. A Research Companion

- present re-entry of the scratchy sound from a vinyl record more than just a "post-digital" sonic fetish; listening to it with a media archaeological ear, "understood" epistemologically, as an index of *LoFi* sound as media criticism and as a technically self-reflective potential of disturbance and noise

- for philology, a text never exits "outside of the physical support that offers it for reading (or hearing)"[645]

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[641] I. Cook, Ancient Acoustic Resonance Patterns Influence Regional Brain Activity, Princeton International Consciousness Research Laboratories Internal Report (2003), referred to in: P. Devereux, Ears and Years. Aspects of Acoustics and Intentionality in Antiquity, in: C. Scarre / G. Lawson (eds.), xxx

[642] See M. S. Bruchez, Artifacts that speak for themselves. Sound underfoot in Mesoamerica, in: Journal of Anthropological Archaeologiy 26 (1), 2007, 47-67

[643] Shintaro Miyazaki, Listening to Wetware Circuitry. Sonic Experimentations and Algorhythmics, in: UN TUNE. CTM - Festival for Adventurous Music & Art, 16th Edition, Berlin 2015, 64-67 (64)

[644] Miyazaki 2015: 65

[645] Roger Chartier / Guglielmo Cavallo 1999: 5, as quoted in Papenburg, op. cit.

- Lauri Siisiäinen, Foucault and the Politics of Hearing, New York (Routledge) 2013, chap. "Message or Noise", 31 ff.

Message or noise? Acoustic archaeology

- implicit sonicity; address “noise” as an essence of technical media

- psycho-acoustic experiment: imagining an ancient phonographic recording of a song or voice; whatever its cultural / semantic content, one will inevitably acoustically hallucinate as well the scratching, the noise of the recording apparatus and storage matter. True media archaeology starts here; allows for phonographic forensics: noise of the machine allows for provenance identification of the archival record; see xxx); phonograph as media artefact does not only preserve the memory of cultural semantics but past *technical* knowledge as well, a kind of frozen media knowldege embodied in engineering and waiting to be un-revealed by media-archaeological consciousness

- in "Listening to Technology"[646], emphasis in favor of *close listening*: to the technological artefact itself; Museum of Endangered Sounds takes care of the sound of "dead media"[647], and the Technical Committee of IASA in its recommendations from December 2005 insists that the originally intended signal is just one part of an archival audio record; accidental artefacts like noise and distortion are part of it as well - be it because of faults in the recording process itself (sender noise) or as a result of later damage caused in transmission (channel noise); two kinds of signals, the semantic and the «mémoire involontaire», message *and* noise

- differentiate between the „social“ respectively „collective“ (Halbwachs) memory of sonic events (auditory memory) and the actual (media) recording of sonic articulation from the past. For an archaeology of the acoustic in cultural memory the human auditory sense does not suffice; track the sonic trace with genuine tools of media studies (which is technical media). One way of „acoustic archaeology“ is to play a musical partition on historic instruments. But the real archaeologists in media archaeology are the media themselves - not mass media (the media of representation), but measuring media which are able to de-cipher physically real signals techno-analogically, and representing them in graphic forms alternative to alphabetic writing, requiring „moving“ diagrams (sine sound is articulation in time): the oscilloscope

Active media archaeology: Sonic revelations from the past

- "sound rescued from the archive" understood in a double sense: a) sound technically retrieved from the archive; b) the non-archival quality of sound

- media archaeology concerned with latent, implicit rather than manifest, directly audible sound knowledge *within* the material dispositive - which is not explicitely turned into written knowledge yet

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[646] See Bijsterveld 2008, chap. 1

[647] See the Website „Museum of Endangered Sounds“, *online* http://savethesounds.info

- ancient Greek *mousiké epistéme*; in the absence of signal processing media, musical analysis served as a substitute for insight into time-based processes. As such the science of music both enhanced and hindered the insight into acoustic media, as in the case of Galileo Galilei. With his experiments of generating sound by rubbing patterned surfaces, Galileo involontarily came close to inventing the phonograph[648]; remained imprisoned in Pythagorean ideology. In sonic articulations he detected primarily music, not "audio": the proof of the connection between numerical proportionality in tonal pitch and the impulse theory of sound

- emphasis on “sound”, has been the most “immaterial” cultural articulation (before the electronic age) already

- historical research primarily text-based archival philology, as opposed to a science of signals. Battles have been described and interpreted, but the real noise and smell of a combat could not be transmitted until the arrival of the Edison phonograph.[649]

- phonography not just providing historical research with a new kind of source material; rather articulated new, rather a-historical forms of tempor(e)ality on the level of the physically and mathematically real (techno/logy)

- Archaeo-acoustics deals with "modern", that is: technological hearing in the sense that it is the sonic media (as active "archaeologists") which reveal these previous sounds of the past. In one of his media artistic projects, the sound archaeologist Paul deMarinis translates "illustrations and engravings of sound vibrations from old physics and acoustics texts, many of them predating the invention of the phonograph"[650], *back* into sound files. DeMarinis finally adds a "technical note": "The traces were scanned on a flatbed scanner, extracted and isolated by a number of processes in Photoshop, then transformed into audio files via a custom patcher in Max/MSP. The sounds were then presented <...> as aiff files played back on a conventional CD player" = 252

- getting tuned to non-canonical epistemology, not by texts and the spoken word, but by a French childrens‘ song: *Au Claire de Lune*. In an act of active media archaeology by the computer itself it has been achieved that the graphic recording of Léon Scott‘s analyses of the human voice could be re-transformed into acoustic articulation. By means of optical reading of signals and application of digital filters, it is possible to digitally trace past acoustic signals from records. From such an operation we expect sound, but really what we primarily hear is noise - just like the first (archived) recording of sound in Norway, a tinfoil flattened to a „document“ and annotated by a remark by a former collector who claims this has been the first Norwegian recording of music on Edison cylinder; digital reading, algorithmic filtering and final re-sonification of this record by a laboratory in Southampton led to a kind of re-sonification where the ear wants to detect something like music or speech - but it actually

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[648] See H. Floris Cohen, Galileo Galilei, in: Paolo Gozza (ed.), Number to Sound. The Musical Way to the Scientific Revolution, Dordrecht et al. (Kluwer) 2000, 219-231 (222)

[649] See Bernhard Siegert, Das Leben zählt nicht. Natur- und Geisteswissenschaften bei Dilthey aus mediengschichtlicher Sicht, in: Claus Pias (ed.), Medien. Dreizehn Vorträge zur Medienkultur, Weimar 1999, 161-182 (175), referring to: Wilhelm Dilthey, Die Abgrenzung der Geisteswissenschaften. Zweite Fassung, in: same author, Gesammelte Schriften VII, 311

[650] DeMarinis 2002/2010: 247-252 (247)

hears nothing but noisy patterns.

- past sound not just "restored" by applying digital filters but has to be remembered with all the traces of decay which has been part of its tradition, its media-temporal (entropic) characteristics must be archivized as well: the scratches, the noise of an ancient phonographic cylinder when being digitized; remain(s) close to the physical record; not just symbolically emulated but a/effectively simulated; " archivize" its temporal (entropic) behavior as well. One method of keeping recorded sound from the past alive known from computing as physical modelling (f. e. in sound reproduction); *granular synthesis* in audio engineering and *physics-based sound synthesis* = digital audio processing logarithms built upon the essential physical behaviour of various sound production mechanisms

- chemical decay of recordings from the past such as Edison cylinders belonging to the essential feature of the sonic record and can now be algorithmically simulated. Not just the recorded sound is emulated, but the chemical process within the sound carrier itself. A "close reading" of a physical record like a magnetic tape is a laser scan of its magnetic field (which can be made visible by chemical colouring) which than can be digitally processed into sound again

- sound, let to its own surroundings, articulates *it*-self, is rather noise such as can be expected in any transmission channel according to the theory of communication developed by Claude Shannons - a theorem which can be extended to transmission in time as well, that is: tradition. In such noise articulates itself what baroque allegories showed as the nagging „tooth of time“ - the articulation of physical entropy, the manifestation of the temporal arrow; according to the Second Law of Thermodynamics each system tends, over time, to increasing dis-order

- "We may assume the received signal *E* to be a function of the transmitted signal *S* and a second variable, the noise *N*. <...> The noise is considered to be a chance variable just as the message <...>. In general it may be represented by a suitable stochastic process"[651] Against this noise of the real culture (especially techno-logical, that is: „digital“ culture) poses a negentropic insistance, a negation of decay and passing (away).

- digital copies of digital records produced almost without loss of data (except the quantization noise); music on Compact Disc or a digital reproduced frequently with stable quality which was utopean in recent times of analoge recording on magnetic tape. The secret of this temporal unvulnerability is that it is just (physical representations of) numbers which are written on the Compact Disc; even after a thousand copies thus a zero stays zero and one remains one[652]

- media-archaeological dispositive for this type of (almost) lossless reproduction of information by identical symbols has been the Gutenberg printing technology (as opposed to handwritten copies of manuscripts) with its negative types to re-produce letters positively in identical numbers - a form of reproduction later re-ivented by the photographic negative, the Talbot Kalotype (as different from the unique Daguerre positive), which led Walter Benjamin to remark that reproduction technology both disconnected and freed (“er/löst“) the reproduced object from the realm of tradition, by replacing the unique event (the condition for its „auratic“

[651] Claude E. Shannon, The Mathematical Theory of Communication [1948], in: ders. / Warren Weaver 1963: 29-125 (65)

[652] Rudolf Taschner, Der Zahlen gigantische Schatten. Mathematik im Zeichen der Zeit, Wiesbaden (Vieweg) 3. Aufl. 2005, note 77

character) by its mass multiplicity. Temporal tradition is thus replaced by a rather topological dissemination.[653]

The tempor(e)ality of „history“ corresponds with the entropic deterioriation of the electric charge and chemical carrier of the magnetic tape *versus* symbolical, i. e. almost time-invariant „tradition“.

- analog sound carrier, which is in-formed physical materiality, can still be identified according to the criteria of the material source-critical method, digital signal transfer primarily is information in its communication engineering sense (given by Shannon), that is: unbound from energy and matter by coding (as Norbert Wiener in his *Cybernetics* insists).

- in media-active archaeology, the technological apparatus itself the archaologist proper. Patrick Feaster and David Giovannoni thus succeeded in re-sonifying the preserved phonautographic engravings (“Schallbilder“), beginning with Scott‘s recording of a sound folk tone of 435 Hz in the year 1859. 150 years later science realized that with optical „reading“ of such acoustic signal lines sound can be re-synthesized, and all of the sudden a children‘s song sounds again. What metaphorically looks like the pick-up of sound images by a „virtual, digital gramophone needle“[654], in fact is something media-epistemologically different, a picking-up of a completely new kind: digital sampling

- "sonophenomenological" (Johann Kroier) listening vs. "acoustemological" (xxx) *understanding* of sound as object / subject of epistemic investigation

A media-archaeological approach to sound

- vibratory affect, according to Steve Goodman, temporally prior to its cognitive perception, even autonomous (Deleuze); "the affective action of a body on a body *precedes and thus conditions* a subject's cognitive response" = Kane 2015: 5; see Angerer / xxx (eds.), Temporality of Affect, xxx; micro-temporality of implicit sound = sonicity; fore-running temporal "attack" of a tone from piano or synthesizer key

- as epistemological approach, media-archaeology of "implicit sonicity" understands "sound" (signals) and "music" (symbols) as an articulation "to (re)organise and reflect events in time"[655]

- temporality of technical media and their affect on human temporal perception; "sonopoetics" *resonating* with Jonathan Sterne's / Tara xxx essay on "The Poetics of Signal Processing"; structural affinity between sound and technical media; both unfold only when being processed

- not submerging sound technologies within an overall historical / social / economical / gender (discourse of) "context", the media archaeological gaze tries to identify social et al. elements *within* technologies themselves and describe their implication not contextually but *implicitely*

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[653] Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit [originally published in its French translation 1936], Frankfurt/M. (Suhrkamp) 1963, 13

[654] Harald Haack, Die erste Klangaufzeichnung. Eine Audiografie, *online* http://newsbattery.blogsport.de/2008/05/07/die-erste-klangaufzeichnung-eine-audiografie

[655]Constantin Engelmann, Auditory Projections, in: Flusser STUDIES 17 (May 2014), *online*

(as in-foldings) - an elementary, "micro-political" approach

- medium-specificity / format specificity or infrastructure specificity. Formats (in terms of streaming data) replace the traditional hardware-bound medium (Stefan Heidenreich's book *FlipFlop*, 2004); transformation of radio (vanishing of Short Wave World Radio which puts us in contact with the Ionosphere so physically); growing oblivion of hardware in algorithmics; even programming has become virtual; physical implementation a marginal aspect of "technical informatics"; programming in Assembler in a media-epistemological context, enlightens the time-sensitive and hardware-relative aspects of computing; an anamnestic project: not media nostalgia but insisting on questioning the aesthetics and discourse of "high level" script languages

- software tools to re-construct past acoustic settings / "auditory displays" (Gregory Kramer); how did Beethoven music sound in now vanished concert halls of Vienna where his compositions were originally performed (Weinzierl); acoustic "amplifiers" ("echeia") in Greek and Roman theatres; tempor(e)alities of sound & media, both in the sense of ahistorical perception of the past in music (temp*aura*lities), and the micro-temporal chronopoetics within sound / electro-acoustic media

- Sterne's MP3 book; series title "Sign, Storage, Transmission". add in brackets: "Symbols"; signal- vs. symbol-based recording, and "processing" (when all the mathematical intelligence steps in)

- deMarinis, on the acoustic tempor(e)ality of a re-sounding ancient Roman bell

Water waves, flimmering air: Order by fluctuation

- challenge to maintain a certain temperature (the notion of *homeostasis*) adapted by cybernetic thought, resulting in a both epistemic (Rheinberger) and technological (Wiener) things: positive, respectively negative), feedback mechanisms. Communication, control, and regulation in "thermal" technologies refers to both sensory and signal transfer in the animal and the machine (Wiener); has been transformed from a physical measure ("temperature") into the mathematical practice ("information"), just like "thermic" heat waves, once mathematically analyzed by Fourier, became literally *transformed* into synthesis from data, thus: computational objects

- signal-to-noise ratio in breaking waves at the seashore appears arbitrary; subconscious "petits perceptions" (such as in listening), according to Leibniz[656], still calculates such phenomena, as nucleus of a statistical theory of noise and random

- Looking out of the window of his office at M.I.T. in Boston onto River Charles, Norbert Wiener (just like Leibniz' intuition of breaking waves at the sea shore) is induced to ask: "Wie konnte man das Studium der großen Zahl der sich ständig verändernden Kräuselungen und Wellen der Wasseroberfläche auf eine mathematische Formel bringen, denn war es nicht die erhabenste Bestimmung der Mathematik, die Ordnung in der Unordnung zu denken?"[657]

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[656] As quoted in Siegert 2003: 182

[657] Norbert Wiener, Mathematik - mein Leben, Düsseldorf / Wien (Econ) 1962, 36

- difference between stochastic noise and well-composed music evident in time reversal: Even if played from tape in reverse, noise sounds equal; Boltzmann's entropy defining the arrow of time

- ergodic ensembles challenging linear time: "If in a Brownian motion, we consider not the position at a given time but instead sets of positions at more than two times, and then take only their differences, then the distribution of Brownian motions over an [...] interval is unchanged by a shift in the origin of time.[658]

Informational aesthetics: Entropy in (cloud) painting

- instead of symbolic order by classification, informational aesthetics (Abraham Moles, Iannis Xenakis) allowing for degrees of disorder, which, in communication theory, implies the highest degree of (possible) information, where the actual message is *one selected* from a set of possible messages = introduction in Shannon, "A Mathematical Theory" (1948)

- different from anthropocentric concept of culture, Max Bense in his claim for an "exact aesthetics" switching to what a neologism might call *entropology*. Bense identifying the *aesthetic state* as the "energy" of an artistic object, resulting from the mathematically contrary components order and complexity as previously defined by Birkhoff.[659] According to Birkhoff, the "aesthetic measure" (M) equals the ratio of order (O) / complexity (C), oscillating around the borderline between O and C = G. D. Birkhoff, A Mathematical Approach to Aesthetics, in: Scientia,September 1931, 133-146; in *The Aesthetic Problem* Birkhoff makes the "aesthetic appeal" of the geometric rotatable (while at the same time shape-invariant) polygon an element for such analysis (Chap. II "Polygonal Forms", 16), provoding the "aesthetic measure" (numerical decimal values) to earch form - the very basis for synthesis in computer graphics (Licklider). Birhoff claims "to answer aesthetic questions by purely mathematical (logical) reasoning" = 46, parallel to Peirce's notion of *diagrammatic reasoning*. Chap. VIII (170-xxx)deals with "The Musical Quality in Poetry", consisting of a) musical quality (poetic significance) and b) time-critical metre (which Birkhoff actually does not investigate); "musical" therefore equals "harmonical"; rhyme, phonetic vowel analysis, tabular analysis (Markov!) of Coleridge's poem *Kubla Khan*; "These computations indicate ..." (185) The less a work of art is redundant (responding to the already known), the more it is *informative* in the engineering sense as developed by Claude Shannon's in "A mathematical theory of communication" (1948); "entropy" as a measure in works of art is a category born from information engineering

- Rudolf Arnheim, *Entropy and Art. An Essay on Disorder and Order*; Entropie und Kunst: Ein Versuch über Unordnung und Ordnung, Köln 1979. Arnheim's preference for an realignment of information with order instead of uncertainty; reminds of a fundamental mis/understanding within the conceptualisation of entropy itself. Shannon focuses on the initial selection of a special sequence of symbols from a limited alphabet, an act which reduces to uncertainty in the prediction of character sequences; intellectual reduction of entropy is accompanied by

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[658] Wiener 1942: 33

[659] Max Bense, Ästhetik und Programmierung, in: Bilder Digital. Computerkünstler in Deutschland 1986, ed. Alex u. Barbara Kempkens, München (Barke) 1986, 22-30 (22). See Fig. *Das physikalische Unordnungsschema im Verhältnis zum ästhetischen Ordnungsschema*, in: Bense 1986: 29

"thermal" noise affecting the signal within the *medium* channel of transmission, making it more difficult for the receiver to separate signal from noise (esp. in cryptography) - a situation well known from philological hermeutics in approaching the multi-interpretability of any intellectual text; see Siegert: Relais 1993: 290

- In Shannon's identification of information with entropy, a particular message reduces the entropy in the ensemble of possible messages (which in terms of dynamical systems is a phase space). Wiener, on the other hand, calls it *negative* entropy; to him - like Arnheim -, information means order, while an orderly thing not necessarily embodies much information. Shannon remarked on that difference: "I consider how much information is *produced* when a choise is made from a set - the larger the set the *more* information. You <sc. Wiener> consider the larger uncertainty in the case of a larger set to mean less knowledge of the situation and hence *less* information."[660] Given that entropy is the extent to which a system is disorganized, Shannon's concept of information (entropy) is inversely related to Wiener's concept of information (negentropy).

- when a photographic reproduction of a painting subject to xerographical miniaturization which then in return is being magnified again, it is subject to gradual entropization: "Umzeichnung des Gemäldes 'Der Bildersaal' von Frans Francken II. Ausschnitte aus dem Prozeß einer fünffachen Verkleinerung und anschließender fünffacher Vergrößerung. Konzept: Ulriche Giersch."[661]

- whereas machine has no criterium at what point a picture is not a picture any more but a shere random distribution of grey or color values (the media-archaeological perspective), only to humans there is a threshold of figurative sens. Emmett William has experimented with the cognitive borderline between what can still be perceived as a meaningful image and an informal electro-static xerographical distortion "mit den Nahtstellen zwischen noch erkennbarem Bild und den informellen Gebilden elektrostatischer Verzerrung"[662]

- Ian Burn 1968: even an empty page, re-xeroxed a couple of time, generates entropic distribution of graphical traces

- media art collective Active Archive has developed the *Ephemerol Scan*, where an archival object is placed on a flatbed scanner and minutely read on various levels of resolution, which are then arbitrarily distributed across the image. "The Ephemerol Scanner turns any object into a field of fluctuating pixels and allows you to move within and between such images through wormholes of corresponding pixels" = annotation to the book cover illustration of Ina Blom / Trond Lundemo / Eivind Rossaak (eds.), Memory in Motion. Archives, Techology and the Social, Amsterdam (Amsterdam University Press) 2017

- website for conference www.suchbilder.de still active; its flash animation making pixels progressively affiliate themselves according to color similarity - a digital code dissimulating physical entropy. Analytically, this corresponds with algorithms which identify, mathematically analyse and sort non-continuous, arbitrary strokes in oil paintings as a new method of

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[660] Quoted after James Gleick, The Information: A History, a Theory, a Flood, chap. 9 "Entropy and its Demons"

[661] From: Giersch 1983: 59 f

[662] Giersch 1983: 67

identyfing individual "styles" in art history

Remark on Surveillance Media (PRISM and sonicity)

- US-American communication surveillance and data storage program PRISM; once started under the name ECHELON after Second World War; no "Pantopticon" but interception - German "Abhören", a term from the auditive field; radio signal transmission of the former Soviet Union to be intercepted by a net of radar stations

- Thomas Y. Levin / Ursula Frohne / Peter Weibel (eds), CTRL[SPACE]. Rhetorics of Surveillance from Bentham to Big Brother, Cambridge, Mass. (MIT) / Karlsruhe (ZKM) 2002. On the NSA: Matthew M. Aid, A Culture of Secrecy 1998

- frequent media-artistic misinterpretation of the soundscape *within* radio antenna spheres: the audio field recordings produced on the former radar detection station on Teufelsberg in West Berlin, under the title *Radarstation 2* by the media art group Fantomton.[663]

- military radar spheres meant to shelter the actual revolving antenna; nothing can be heard but peripheral sounds (like the cooling aggregate), while the actual short wave radio signals had to be demodulated and amplified by special radio receivers to be transduced into audible articulations which then could be decoded by human ears *via* earphones or loudspeakers; presence of sound in such spheres is sublime in the sense of Edmund Burke; one is aware of them but can not perceive them with human senses; classify such phenomena of "implicit sound" under umbrella term *sonicity*; "das Sonische" (sonicity) as implicit sound, sound as an epistemic artefact

- in contemporary radio wave transmission, signals coded in binary impulses. Pulse Code Modulation (whose "philosophy" was aptly described by Claude Shannon[664]) in fact, has first been developed first for the most secret system of high command telephony SIGSALY in the Cold War era, but the acoustic event here has not been the actual telephone conversation (which was rather encoded in teletyping), but the so-called one-time pad which consisted of twin records with completely noisy signals - the most secure random key for en- and decryption

- PRISM system not "listening" to analog radio waves but "reads" discrete alphabets, embodied in electromagnetic pulse transmission over fiber glass cables for data exchange and transfer in the Internet. Just as Walter Ong has described the phonemenon of a return of orality in the electronic age (termed "secondary orality"), there is a re-turn of reading in telecommunication - but not for visual perception any more (the eyes), but for computer algorithms which filter data streams; traditional interception of radio communication replaced

- sonification of electro-magnetic emissionen from computer monitors; "Van-Eck-Phreaking"; Markus G. Kuhn, Electromagnetic Eavesdropping risks of Flat-Panel Displays, University of Cambridge (Computer Laboratory) 2004; *online* http://www.cl.cam.ac.uk/~mgk25/iss2006-tempest.pdf

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[663] http://fantomton.de/experimente/radarstation-2-call-for-tracks/

[664] Claude Shannon, Philosophy of PCM, in: xxx

- "mathematical sonicity" of *quasi*-muscial structure (in the Platonic sense) without being audible at all any more; digitisation of radio transmission (as practiced almost universally today) actually "silenced" the traditional radio channels. The answer is: no, just that the audio-(or rather radio-)sphere of telecommunication has turned from the explicit to the implicit sonification[665], from direct audification of wave forms (corresonding with the electro-mechanical transducer in phonography) to indirect parameter mapping of discrete data points, from acoustic sound to mathematical sonicity. For his PhD thesis *algorithmisiert*, Shintaro Miyazaki's series of experiments in the sonification of algorhythmic data which govern our tele-communication, with specific media conifgurations like detectors of electro-magnetic waves ("EM Sniffer") themselves acting as non-human archaeologists of such knowledge. For the accompanying audio CD as integral part of the textually expressed argumentation, which by the very nature of its topic (the rhythmic dimension of computing) requires steps beyond what can be expressed within the Gutenberg galaxy, Miyazaki e. g. transposed the sonically so-called "Daktylen" in frequency- and time multiplexing of GSM mobile telephony <Diss. Miyazaki: 185 f.> into audible sound; thesis Miyazaki fig. 4.17, p. 186, shows scheme of GSM-Daktyla; *online from w*eb site Kulturverlag Kadmos, book presentation *Algorithmisiert*

Sonic delay and media time

- delay time (caused by the inertia of matter) and run time *(alias "*dead time") unfolds as temporal interval between a system input and its response at the output. As transport time, this refers to micro-mobility on the media-archaeologically accessible ground level of electronic circuitry. "The time it takes for material to travel from one point to another can add dead time to a loop. <...> The distance may only be an arm's length, but a low enough flow velocity can translate into a meaningful delay."[666] This form of a temporal *inbetween* is central to the notion of media itself. Time in communication itself is "medium" in Claude Shannon's functional definition of the channel of transmission.

Explicit sound and implicit sonicity as temporal knowledge

- genealogy of term *sonus* ranging from the concrete physical materiality of sound up to its epistemological definition = Frank Hentschel, entry "Sonus", *online* www.sim.spk-berlin.de/static/hmt/HMT_SIM_Sonus.pdf (accessed July 2013); retro-neologism *sonitas*

- privileged alliance between technological media and music and / or sound, based on the assumption that their common denominator is its temporal processualities; neo-logism sonicity does not refer to the apparent phenomenological quality of sound but rather to its essential temporal nature which is its subliminal message behind the apparent musical content; sonic media; time signal and its technical processing converge

- discovery of sound not as acoustic but as epistemic object: implicit sound ("sonicity"); temporality of sound which couples it tightly to the essence of media operativity

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[665] See Thomas Hermann / Andy Hunt / John G. Neuhoff (eds), The sonification handbook, Berlin (Logos) 2011

[666] Doug Cooper, Dead Time Is The "How Much Delay" Variable; *online* unter: http://www.controlguru.com/wp/p51.html

- term "sonicity" not referring to the apparent phenomenological quality of sound but to its essential temporal nature which is its subliminal message behind the apparent musical content; Marshall McLuhan's central argument ("the medium is the message") in *Understanding Media* (1964)

- Martin Heidegger's ontology of technology: "The Question Concerning Technology", in: Basic Writings, edited by David Farrell Krell, San Francisco (Harper Collins) 1993, 307-342; The Question Concerning Technology and other Essays, New York (Harper and Row) 1977

- archaeonautics of sound: sonic analytics within big audio data and options of algorithmically navigating them

- term borrowed from computer programming, "recursions" not simply historically situated variations but challenging the historical order of events itself as technologically implemented chrono-automatism; thinking media time in technological terms

"sonic" illustrations?

- printed texts necessarily excluding sound matter; in a deeper sense, there is implicit sonicity in diagrams and graphs that are derived from sound sources, and by optical scanning graphic information (even an image of an early gramophone record) can be re-sonified "again"; sonagram (spectrum analysis) or sonogram (ultrasound-based visualization) maintaining an indexical relation to the measured event in diagrammatic sonicity

- genealogy of technologies to visualise sound and the human voice (in terms of signal recording and its spectrographical analysis) = Mara Mills, Deaf Jam. From Inscription to Reproduction to Information, in: Social Text 102, vol. 28, No. 1 (Spring 2010), 35-58

- out-spoken book title *Sonic Time Machines*; digital file (after sampling) expressed as wave visualisation (oscillogram), and as frequency domain (spectrogram), to demonstrate the "analog" and "digital" aspect of argumentation "by itself"; sonicity not just metaphorical, but rather self-expressive; spectrograms on the y-axis either linear, or *logarithmic*

Calculating waves: notes on "sonicity"

- media-archaeological level: sub-phenomenological "acoustic quanta" as time-objects (Gabor) vs. higher levels of "musical" dramaturgy as symbolic ordering of time

- McLuhan not sufficiently differentiating between „electric“ and „electronic“. With electronics, electricity does not count in its physical energy any more (as for lighting and the electric engine) but is used as a micro-energy for the intelligent manipulation (as in the vacuum tube triode for amplification and feed-back), leading to an electrified "culture without writing"[667]. In digital electric information systems, all of the sudden, wiring becomes writing again - a symbolic order (as identified in Claude Shannon's Master Thesis *A symbolic analysis of*

[667] See Herbert Marshall McLuhan, Kultur ohne Schrift, in: Martin Baltes / Fritz Böhler / Rainer Höltschl / Jürgen Reuß (eds.), Medien verstehen. Der McLuhan-Reader, Mannheim 1997

switching relais, 19xxx); different kind of textuality returns

- Jenny borrowing neo-logism "Kymatik" from Ernst Florens Friedrich Chladni's "Klangfiguren"; see Marco Bischof, Biophotonen. Das Licht in unseren Zellen, Frankfurt/M. (Zweitausendeins) 1995, 219

- "degaussing" (Bill Viola's "sonic" definition of video image): when switched on to clear remnant electric charges that might disturb the image, the degaussing coil wrapped around the neck of a cathode ray video, television or computer monitor causes a rapidly oscillating magnetic field; this high current surge actually "is the cause of an audible 'thunk' or loud hum which can be heard" = entry "Degaussing" in http://en.wikipedia.org (accessed April 7, 2014)

- resonance, signaling, processing; distinctions between recording, transmission, and architectural technologies; between hearing, listening, and sound objects themselves; between different kinds of recording (alphabet vs spectrogram); differences electroacoustics makes; subthemes of digitization, time, or processing

- terminology in analog electronics such as "resonant circuit" by necessity borrowed from musical science as age-old substitute science of time / temporalities / time-based arts; aspects of coding, compression, etc. derive from telegraphy or communication engineering ("entropy"), not from the sonic sphere

Ontological "being" vs. sonic "beeing" (electronic imaging)

- in image compression algorithms, for a temporal interval *within* image processing for efficient transfer, even a two-dimensional static image like photography kind of "sonic" existence in the channel when being compressed by Discrete Cosine Transformation, before finally being transformed "back" into a two-dimensional image (for human eyes)

- "sonicity" conceptualizing sound not for its acoustics, but for its temporal form; Baird's Phonovisor not only by its very name but by its gramophone shape reminds of an unusual way of "looking" at signal-based images via sonic signals; book *Chronopoetics* confusion about term "beeing" of electronic media - typographic error or explicit pun? electronic dictionary: "Beeing = archaic spelling of being"; spelling of "beeing" used in reference to Heidegger's "Seyn": *Beeing and Time*; Heideggers's writing of German "Sein" = being as "Seyn"; the pun of the bee humming makes sense in electronic imaging: "Spoken in terms of music the physical appearance of a transmission is a kind of humming noise. The video image repeats itself incessantly in the same frequency range. This new general state of humming represents a significant shift in our culturally derived thought patterns" = Bill Viola, Der Klang der Ein-Zeilen-Abtastung / The Sound of One Line Scanning, in: Theaterschrift no. 4 (issue The Inner Side of Silence), Brussels (September 1993), German / English, 16-54 (26)

- television images transmitted as electro-magnetic waves, with "the fluctuations being determined by the shape and / appearance of the object or scene being transmitted. If the fluctuating electric current is received on a telephone in place of a televisor, a noise is heard, this noise having a different character for every object, so that every scnee may be said to have its corresponding 'image sound'" = Edgar Larner, Practical Television. With a foreword by L. Baird, London (Benn) 1928, 167. "By recording these sounds on a phonograph, a permanent record can be taken, and if these records are played again into a microphone connected to a televisor working in synchronism with the phonograph, the original image is reproduced [...] so

that we have a means of storing living images upon phonographic records. Mr Baird has given the name of 'Phonovisor' to this device [...] = ibid., 168; "replica" of the Phonovisor would materially (very media-archaeologically) remind of the implicitely sonic nature of the television signal, and thereby undo the all too familiar distinction communication studies make between "auditive" and "visual" mass media. My concept of implicit "sonicity" may look rather idiosyncrativ at first glance, but my be techno-epistemologically justified in the context of signal analysis

- media archaeology identifying the media-epistemological impulse): "From 1926 onwards, Baird and his team significantly improved the opto-mechanical 30-line television system [...], increasing the image rate to 12.5 per second, yet still allowing the 30-line television signal to be broadcast as if it were an audio signal. This was a deliberate choice by Baird to get a television service on air soonest using the BBC’s existing audio broadcasting infrastructure. This, more than any technical limitation with camera systems or the like, was the reason the Baird Company appeared to persist with 30-line broadcasting from 1929 to 1935" = Donald F. McLean, The Achievement of Television: The Quality and Features of John Logie Baird’s System in 1926, in: The International Journal for the History of Engineering & Technology, Vol. 84 (2014), Issue 2, 227-247 (244)

- in analogue electro-magnetic wave transmissions (either sound or vision), the modulated information reduced to a single electrical signal that varies in voltage (or current) with time. "At any instant, there is only one value" (communication Donald McLean, 22 September, 2017); the essential time signal unfolds in the tempoReal, within real numbers which no discrete symbolic machine can grasp, in principle (Turing 1936) / *en arché*. "Analogue television is communicated in the same way as sound - that single electrical that changes in amplitude with time" = McLean ibid.

"Improved Terpsitone" (Teremin / HU)

- media dramaturgy; Sean Michaels' 2014 novel lets a fictionalized Lev Sergeyevich Termen describe: "My theremin is a musical instrument, an instrument of the air. Its two antennas rise up from a closed wooden box. The pitch antenna is tall and black, noble. The closer your right hand gets, the higher the theremin’s tone. The second antenna controls volume. [...] always you are standing with your hands in the air, like a conductor. That is the secret of the theremin, after all: your body is a conductor" = quoted from "Foreword" Liam Cole Young to W. E. *Sonic Time Machines*., referring to Sean Michaels, Us Conductors, Toronto (Random House Canada) 2014, 16. In fact, the body becomes a non-metaphorical condenser. Devices like the theremin generate a low-frequency signal audible to human ears by integrating two electric oscillator frequencies (*Schwebung* by interference). "The new, strange sounds of the electric avant garde would fundamentally transform the Western acoustic canon." The sound of the theremin is pure electric alternating current; it does not pass away like the natural tone, but persists, stays, keeps, lasts

- Terpsitone extended version of the etherophone where one dances inside two antenna circuits to modulate tone and pitch - named after the ancient Greek muse of dance; not only re-built this amazing form of intuitive "sonic" interface, but present an improved version: Implementing (by analog-to-digital conversion) the ancient Greek musical tuning (Aristoxenos) one actually experiences the somewhat different kind of "musicality" ancient Greeks had in their ears. Turning media-technological, electro-acoustic experience into knowledge

Discovering the ears on Flusser's face

- Flusser in his Sao Paolo lectures on (electronic) music, 1965; directs attention to the machine-induced noises of the modern world like "the syncopated rhythms of machine levers" and of "typewriters" replacing former symbolical social and festive rhythms, close to Marhall McLuhan's definition of the electronic age as "acoustic space" = Marshall McLuhan (with Edmund Carpenter), Acoustic Space, in: same authors (eds.), Explorations in Communication. An Anthology, Boston (Bacon Press) 1960, 65-70; Flusser distinguishes the present situation by its "acoustic character rather than a visual one" = Lecture 16

- Xenakis regarding programmed and electronic sounds: "We are all Pythagoreans"; after World Fair of 1958 foundation in Paris Studio *CEMAMu* (Centre d'Etudes de Mathématique et Automatique Musicales); with UPIC program generating (Unité Polyagogique Informatique du CEMAMu) graphical curves curves, drawings; parallel Meyer-Epplers physico-mathematically founded sound and informational aesthetics theory; cybernetic epistemology

- media-induced electronic music which is not just an extension of the classical instrumental tradition but a new quality, corresponding with music in its purest (Fourier-)analytic form. "The tape composed by the composers is the immediate articulation of the intellect. It means nothing, but it expresses directly the structure of thought" = Lecture 16; Flusser celebrating electronics as a cultural form induced by technologies based on the electro-magnetic field; magnetic recorder described by Flusser as the true archaeologist of the sonosphere, listening with technological ears without evaluating music from noise: "A random sound is recorded on tape: may be the sound of a bell, or of a locomotive, or of the human voice reciting a verse from the Bible. "The tape is recorded and then cut-up, and its segments are then submitted to deliberate manipulation. They are amplified, twisted or condensed. The segments thus manipulated are then re-composed onto a new tape, in a deliberate order and structure, that is, vertically, horizontally, diagonally and in a sequence hat is independent from the primitive tape. This is a composition in the strict meaning of the term" <Lecture 16>. Flusser is a true contemporary of William Burrough's acoustic cut-ups and their posthuman assumtions.[668] Music as intellectual concept turns into sound only when implemented into the physical world which is the moment when parameter *t* (the time axis) is involved: "The tape is then played through an apparatus for sound reproduction, and we can then experience this music acoustically, this is, in its temporality" <Lecture 16>. Only the embodiment of musical compositions into physical materiality provides it with a temporal dimension which defines sonicity against pure concepts - just like an algorithm is not yet computing but needs an operative computer to be executed in time. Mathematics is not able to perform itself; a diagram for sound synthesis as well needs a real electronic synthesizer to happen as sound.

- Flusser correlating the options of electronic music with non-Euclidean geometry as much as McLuhan does in his later work.[669] A kind of sonification might transpose mathematical equations onto tapes, just as a techno-mathematical theory of music has been developed by

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[668] On William Burrough's audiotape cut-ups from the 1960s see N. Katherine Hayles, How We Became Posthuman. Virtual Bodies in Cybernetics, Literature, And Informatics, Chicago / London (University of Chicago Press) 1999, 208 f.

[669] See Marshall McLuhan / Bruce R. Powers, The Global Village. Transformations in World Life and Media in the 21st Century, Oxford et al. (Oxford University Press) 1989

the avantguarde engineer of digitally controlled analog synthesizers Erkki Kurenniemi.[670]

- electronic music "appeals directly to our intellect" <Lecture 16> in sonic understanding but is hindered by cultural accommodation to traditional music which "still mobilizes our sensitivity" = ibid.

- Flusser longing for the ahistoricity of techno-structural sonicity. Training in listening to electronic music will help humans "to grasp the beauty of pure thought" = Flusser in his Sao Paolo lectures on (electronic) music, 1965, lecture 16; "pure sine-tone" (Eimert / Stockhausen) oscillator in electro-acoustics and the binary computer for digital music composition, re-called as *a posteriori* precursor of such "pure music" both as sound and as mathematical sonicity in its perfect articulation Baroque music; in the emerging epoch of electronic music (Flusser's lectures in 1965) "currently in all of our programs <...> composers such as Vivaldi and Tartini are going through a rebirth" <Lecture 16>. This iteration (to remain within the algorithmic language) demands for a nonlinear description of the chrono-logics of implicit sonicity. Thereby when "concerts are enacted with authentic instruments from the fifteen hundreds" <ibid.>, what is named "historically informed performance" in fact is experimental archaeology, archaeo-acoustics not in its chronological but structural sense - both in terms of the materiality (instrumental behaviour) and the intellectual concept of music

- Flusser's clear differentiation between the symbolic regime of musical mathematics and its temporal implementations as sound leading directly to a media archaeology of sonic articulation

Non-semantic media expressions: channel noise

- *psophos* ancient Greek "noise", esp. the physically determined tone (Latin *sonus*); Digital Psophometer, model 1072: featuring Measurement of Metallic Noise, Longitudinal Noise, Level and Transmission Loss Over a Transmission Line, Recorder Output

- conference *Beyond Noise - Acoustic, Technical and Metaphorical Aspects of Noise in Music and Visual Arts*, UCSB, 1-3 August, 2002; Schweighauser, "literary acoustics"

- radical aesthetics, beyond "social" interaction (human-human), encompasses human-machine and machine-machine communication

- "anti-noise"; "signal to noise" ratio, noise vs. order, low-frequency and low-amplitude noise, noise and silence

- Hillel Schwartz, Making Noise. From Babel to the Big Bang and Beyond, New York (Zone Books) 2011

- after noise has been discovered as a techno-cultural dimension worth of attention, it looks as if it vanishes again into the dark (or rather into silence): the digital realm, with its

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[670] See Mikko Ojanen et al., Design Principles and User Interfaces of Erkki Kurenniemi's Electronic Musical Instruments of the 1960's and 1970's, in: Proceedings of the 2007 Conference on New Interfaces for Musical Expression (NIME07), New York, NY; online: http://www.nime.org/2007/proc/nime2007_088.pdf

mathematical codes, is conceptually noiseless in itself; noise there just turns into a surface effect, an artificial re-entry of past media. After an epoque of avantgarde-liberation of sound from music, of emancipating noise in explicitely sense-less (nevertheless sensible) ways, in digital "noiseless communication" the limits of hardware still insist on the irreducible noise of matter

- musical composition (different from physical sound) not in need of recording on magnetic tape, gramophone or Compact Disc (the age of reproduction / repetition); sufficient if generative algorithm can be located, to re-generate

- radio-telecopes, registering rather noise than harmonies from deep space; there is no (more) soul" as a medium of processing sound into harmonics

- technical media immediacy by noise? noise a way of sensually experiencing communication theory (Shannon)

- noise as a specific expression of thermionic tube / Schrot-effect

- media archaeological aesthetics, which Attali deciphers for composers like Xenakis: *dépersonnalisation*, „vide de sens“, without code <1977: 185>, that is: re-archeologizing the sound; "empty formalism" (Brian Eno) essence of computing

- noise (*eigenrauschen*) as evidence of the medium is hidden, suppressed, by so called content and interfaces; comes forth in moments of technical breakdown

- noise generated as impulse for Techno music from *analog* synthesizers

- materiality of hardware noisily re-emerging against the purist aesthetics of virtual worlds (where there is no noire, no physical decay

- aesthetics of "live" recording phenomenologically identified by the presence of noise

- Lauri Siisiäinen, Foucault and the Politics of Hearing, New York (Routledge) 2013, chap. "Message or Noise", 31 ff.

- photographic image surface aesthetics which is diffractive distribution of photo-chemical noise / silver halogenite grains / crystalls, literally; optotechnical gaze, sonotechical listening

- acoustic (different from visual) noise and technical time-signal a *time-based* event, that is: can only be perceived in a dynamic process, never ever at a single given moment or *punctum temporis*

- sampling as enduring repetition of minute particles by the pattern-oriented interface of sequencer programs like Cubase and Logic = Rambow xxx: 183

- noise as a mode of measuring, like acoustic runtime tomography for locial weather-forcast

Beyond noise? Discrete numbers

- mathematical stochastics calculating with noise, literally; being a deterministic system,

turingmachine not knowing noise; can only simulate / preuso-noise

- noise knowing the real world / aboput the world of the real, that is, the symbolically incalculable; noise absorbs so much more storage space when it is to be remembered or to be processed in realtime" = Hillis: 114

- end of 1920s Baird's *televisor*: "In these early prototypes, a transmission could be considered successful as long as an image took shape against the choppy grey static. <...> But if these images rush to make a claim on reality, it rests on the fact of transmission - reproduction at a distance - not on the veracity of its representations" = Richard Dienst, Still Life in Real Time. Theory after Television, Durham / London (Duke UP) 1994, 20

- audio / visual noise a media-archaeological reminder of media immediacy: message or noise?

- analog/digital conversion does not only filter out the noise of materiality, but as well introduces new kinds of noise: "The digitization process introduces errors into the signal, which can be approximated by a Gaussian noise source with a magniftude equal to the least significant bit. <...> Similar devices operate in the opposite direction in *Digital-to-Analog Converter* (*DAC* or *D/A*). A resistor ladder can be used to convert a set of bits to a voltage."[671]

- often, in digitally sampled music, an artificial re-entry of noise into Dolby-clean digital space, to remember the past epoque of analogue electronic media (thus the analogue syntheciszer is still in vogue, like DJs use venyl, still)

- extend *theorein* to *akouein*; from symbolic regime to *noise*, signals

- *The Matrix*, data- and number-clouds: „trace program running". Such a texture of digital codes, of course, is not noise, but pure mathematics, against material physics. Does noise corresponds with „the real“ (in Jacques Lacan´s sense), does it have a privileged relation to the real / do technical media, since photography (ghostly taches) and the grammophon (being able to record non-semantic information) have a direct access to the real as opposed to the iconological / alphabetical symbolic *order*?

- John Cage, no „beyond noise“ in the real world: In his piece for piano *4´33* where no key is struck, the silence of music makes the background noise of the piano player´s body and the surrounding noise audible; computer as well: with no operation by the human user, the machine runs to build an empty window on the terminal at all

- Can the language of literature express this transformation of cultural aesthetics into audiovisual, noisy surroundings? Can the audiovisual media be interrogated by semantics? Don DeLillo tries it in his novel *White Noise*, taking as his title the acoustic and visual background of a running TV set without reception that has become the constant background of American life.[672] *White noise* does not mean nonsense, but a ceaseless particle stream of information in constant motion[673]; this metaphor (Schweighauser's oxymoron of "literary acoustics") of white noise permanently carries the media-archaeological memory of that moment when the images are not yet messages, but simnply signal media (end of 1920s, Baird etc.). "In these early

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[671] Neil Gershenfeld, The Physics of Informatic Technology, Cambridge (UP) 2000, 222

[672] Walter Moser, Eppur si muove!, in: Goebel / Wolfgang Klein (Hg.), xxx <Festschrift Lämmert>, 1999, 238

prototypes, a transmission could be considered successful as long as an image took shape against the choppy grey static. <...> But if these images rush to make a claim on reality, it rests on the fact of transmission - reproduction at a distance - not on the veracity of its representations."[674]

- Photoshop post-production options: remove / add noise

- in technological and channel noise, the medium revealing itself (with Shannon)

- no total (white) noise; „noise“ itself already a rhetorical figure, an idealization of something which does not ever exist in pure form; always already structure, figuration, pattern: so-called "white noise" (background noise) a hermeneutic or aesthetic abstraction, since it does not exist physically

- digital regime, with its mathematical codes, noiseless in itself; noise there just turns into a surface effect, an artificial re-entry of past media. After noise has been discovered as a techno-cultural dimension worth of attention, it looks as if it vanishes again into the dark (or rather into silence); noise just turning into a surface effect, an artificial re-entry of past media. Emblematic of this re-entry is Mike Figgis´ film *Timecode* (2000). While its squared, quadrupled screen with four parallel continuous actions shot with digital video itself allegorizes the nature of the pixel-based digital image (4 mega-pixels, so to say), the dramaturgical invention of letting moments of earthquakes cut through the segemented images every once in a while is like an allegory of the disruption of representation itself, the flash-like invasion of the analogue world into clean digital space.

- limitation of the "digital" by its very hardware which insists on the irreducible noise of matter

- quantum computer difficult to construct because the slightest background noise (like cosmic rays of even the backgropund noise of so-called "vacuum" itself) destroying the fragile equilibrium of relational qbit states = Hillis 2001: 95

Beyond noise? Breaking waves

- human cognition phenomenologically tending to read figures out of ground noise; making sense of meaninless stochastic patterns (Electronic Voice Phenomenon); otherwise compressing algorithms for streaming data in computing not acceptable; non-human senses sensitive to noise, when communication happens not only between humans any more

- Leibniz, in the breaking waves at sea shore, hearing nature calculating (integrating / differentiating) itself, *nesciens* "sampling" sound waves; calculating takes places only in the "Zählorgan Ohr" = Georgiades 1985: 42; take away a pebble, the empty hole shapes literally "zero", "zifra" = "Nothing": a form (of absence), impressed on the medium, which is sand; Harris 2001: 120; the noisy limit of the digital computering: although materially built on sand (silicium), not able to calculate the random distribution of sand (otherwise aliasing effects).

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[673] Edouard Bannwart / Daniel Fetzner, Reflexionen – die Wissensmembran, in: Ausstellungkatalog *7 Hügel / VI: Wissen*, Budde / Sievenich (Hg.), Berlin 2000, 27

[674] Richard Dienst, Still Life in Real Time. Theory after Television, Durham / London (Duke UP) 1994, 20

And a human image drawn into the sand will (with Foucault) vanish in specific waves in ways no digital computer will ever be able to emulate. This image, after a while, will rather look like the jammed images in early analogue TV = Hillis: 121; a digital images of a pebble beach can easily be compressed, that is: calculated (of course the Latin word calculatin is derived from calculi themselves, that is: counting with pebbles in the sand

Sonic analytics

- *cultural analytics* or rather "cultural spectographics" (for audio content)

- item in Berlin Lautarchiv no. (ID) 9311 (type "Plastisches Objekt"): two electro-magnetic pick-ups, conditioning re-play from the media-archaeological side

- current audio analysis software displaying predominantly visual interfaces (waveforms, spectrograms), as indicated by the very name of Sonic Visualiser, representing time, frequency and energy of the sonic event

- instead of automatically generating metadata out of the sound material (the logocentric appraoch), navigate within the signal space itself; in signal compression formats like MPEG7, the metadata and the sampled signal data are two parts of one package

- commercial uses: automated semantic music analysis; Praat (developed in Amsterdam for open source phonetic research); standard software for speech analysis on signal basis; Audacity which allows for frequency analysis (spectrogram / sonagram), displaying how the energy distribution changes in the frequency band *over time*; Sonic Visualiser allowing for the comparison of different recordings of the same musical piece and to nagivate across a number of such recordings - e. g. "how Rubinstein played Op. 6 No. l in his 1939, 1952, and 1966 recordings"[675]; further allows for detailed analysis of performance timing[676]

- In 2003, Vodafone mobile phone provider with option for the recognition of melodies or songs which were accidentally heard and of interest for users. By dialling a specific number, a large data bank of songs could be addressed; then the cell phone had to be directed about 30 seconds at the sound source in order to get an SMS which provided the demanded metadata (title, artist)[677]

- media-artistic application: Dumb Angel by Klaus Gasteier (KHM Köln) = "Dumb Angel. Brian Wilson wird interaktiv", in: SPEX 9/1996

- MARSYAS = Music Analysis Retrievl and SYnthesis for Audio Signals = free software framework "written" by George Tzanetakis

- music information retrieval (MIR) as non-verbal mode of accessing music archives - once they have been digitized, that is: mathematization of the signal (intelligence) - operates from within

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[675]Nicholas Cook / David Leech-Wilkinson, A musicologist's guide to Sonic Visualiser, <URL?>

[676] See Jopsé Bowen, Tempo, Duration, and Flexibility Techniques in the Analysis of Performance, in: Journal of Musicological Research 16 (1996), 111-156

[677] Note "Erkennen Sie die Melodie?", in the Berlin program journal: zitty 21/2003, 80

the sonic matter, "based on musically substantive features such as chords, motifs, rhythms, etc."[678]

- in signal compression formats like MPEG7, metadata and the sampled signal data two parts of one package; learn how to navigate within technical metadata

New options of sound retrieval

- necessity of digitizing phonographic records against physical decay, epistemological option emerges; SpuBiTo project = www.gfai.de: "The retrieved sound documents can directly be stored on digital media (e. g. CDs) for archiving or processing"; "big data" generated by retro-digitization of analog sound archives; surplus value in the algorithmization of these data, not pure quantity; unstructured data as such useless

- in audio data "mining", the sonic signal addressed directly; Databionic MusicMiner, developed at the University of Marburg, heavily relying on the funcitonality of the Databionic ESOM Tools (Self-Organising Maps): a browser for music based on data mining techniques. By that software one can create MusicMaps to visualize the similarity of songs and artists. Features include automatic parsing and similarity search based on sound itself

- F. Moerchen / A. Ultsch / M. Thies / I. Loehken, Modelling timbre distance with temporal statistics from polyphonic music, in: IEEE Transactions on Speech and Audio Processing, vol. 14, no. 1 (2006), 81-90

Inbetween media archaeology and cultural semantics

- "semantic gap" between the hermeneutic approach (cultural "understanding", musicology) and the explicit measuring approach (enhanced by appropriate instruments); measuring melodic similarity, human *versus* algorithmic judgements clash[679]; hermeneutically disciplined human perception identifies causal relationships between temporally adjacent events, while algorithmic signal processing in big data (such as the NSA or Google "archives") identifies *correlations*, potentials for predictions

- on the micro-acoustic level such re- and protention has been discussed to explain melody experience by Edmund Husserl and Henri Bergson; fits into what neuro-science calles the time-window of "the present" perceived within humans: about three seconds of duration

- Predictive Analytics today: "Dazu sammelt man Daten und durchsucht diese mithilfe von Algorithmen nach Regelmäßigkeiten, die man dann in die Zukunft extrapoliert"[680]

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[678] Juan Pablo Bello / Kent Underwood, Improving access to digital music through content-based analysis, in: International digital library perspectives, vol. 28 (1), 17-31 (*abstract*)

[679] Daniel Müllensiefen / Klaus Frieler, Measuring melodic similarity: human *versus* algorithmic judgements, in: Conference on Interdisciplinary Musicology, Proceedings CD-R, Graz

[680] Entry "Predictive Analytics" in the *Glossar* of Heinrich Geiselberger / Tobias Moorstedt (Redaktion), Big Data. Das neue Versprechen der Allwissenheit, Berlin (Suhrkamp) 2013, 301

- different from hermeneutic understanding (German *Verstehen* resonates with its acoustic sense) Joseph Carl Robnett Licklider researching to which extent speech can be distorted and still remain intelligible: "Distortion is most easily thought of as a deformation of a function of time or of frequency"[681] - auf jenem "rather microscopic level on which I want to consider it" = ibid.. "In order to discuss intelligibility, on the other hand, it will be necessary to work with elements: phonemes, syllables, words, or sentences" <ibid.>. Sonic knowledge oscillates between the media-archaeological and the proto-semantic (cultural) level: "Therefore we shall have to engage in an exercise in shuttling back and forth between the level of functions and the level of elements" = ibid.

Algor(h)ithmically driven sound analysis and its tools

- sonic analytics (in accordance with "cultural analytics" as developed and declard by Lev Manovich); media-active revelations from search algorithms themselves. "Where auditory analysis necessarily takes place *in time* and thus *takes* time, the audiospectrograph stabilizes time through combination and scaling"[682]; *sonic diagram* replaces the visual interfaces (dominating human-computer-communication in audio analysis)

- pre-condition for sound analytics to describe the audio signal *from within*. This partly reminds of the MPEG-7 standard to describe multi-media content, particularly its 17 low level descriptors which are both temporal and spectral "from within" sonic articulation

Automatic music transcription (AMT)

- Software trAVis (Musikzentriertes Transkriptionsprogramm für AV-Medien) siehe Christofer Jost, Computer-Based Analysis of Audiovisual Material, in: Dimitri Zakharine / Nils Meise (eds), Electrified Voices. Medial, Socio-Historical and Cultural Aspects of Voice Transfer, Konstanz (Unipress) 2012, 359-375

- *sonic* signals previously requiring human decoders to be transcribed into *musical* scores; for media-archaelogical ears of data processing devices, audio signals can be automatically turned first into digital samples - with the digital audio signal $s(n)$ representing a transformed time signal by means of the time index n

- sampled audio signal can be processed into formats like the spectrogram, and/or be printed as conventional musical score by the digital Score Generator. What has been first developed for automated speech analysis is extended to the musical field. The "Onset Detector" recognizes the beginning of regular notes; primarily this automated analysis gives access to the temporal realm of the sonic event by identification of micro-temporal structures, beats and rhythm; real time components of such a software creates waveforms to be analyzed by

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[681] J. C. R. Licklider, The manner in which and extent to which speech can be distorted and remain intelligible, in: Cybernetics / Kybernetik. The Macy-Conferences 1946-1953, Bd. 1: Transactions / Protokolle, hg. v. Claus Pias, Zürich / Berlin (diaphanes) 2003, 203-247 (203)

[682] Joeri Bruyninckx, Sound Sterile. Making Scientific Field Recordings in Ornithology, in: Trevor Pinch / Karin Bijsterveld (Hg.), The Oxford Handbook of Sound Studies, Oxford et al. (Oxford University Press) 2011, 127-150 (144)

Discrete Fourier Transformation and then is (re-)translated (re-mediated, in fact) into culturally familiar categories of musical time structures like Harmonic Analysis. "Grundlegend ist die Tatum-Erkennung. Dieses Kunstwort wurde von 'Time Quantum' abgeleitet und bezieht sich auf das kleinste im Eingangssignal gefundene Zeitintervall. Hierauf baut der Beat (*Tactus*) auf, welcher mit dem wichtigsten wahrnehmbaren Puls gleichgesetzt wird" = Roland Stigge, Automatische Musiktranskription (ATM), paper from June 16, 2003, developed at the chair for Signal Processing and Pattern Recognition at the Institut of Computer Science, Humboldt University, Berlin; accessible *online* http://www.antcom.de/~stigge/studium/amtarticle.pdf (Zugriff Juli 2013); apply to even higher levels of sonic dramaturgy (which is the culturally familiar "musical" ordering of time)

- Denis Gabór proposing "acoustic quanta" as subliminal temporal elements from which sound can be calculated in the true time domain (and not pre-supposing eternally periodical wave forms like in the classical Fourier Analysis)

- a signal-endogenic archive no longer listing songs and sonic sequences according to their authors, subject, and time and space of recording. Instead, digital sound data banks will allow acoustic sequences to be algorithmically systematized according to genuinely sonic (i. e. wave-based) notions and computing (techno-mathematical) criteria rather than traditional musical *topoi*, revealing new insights into their non-symbolical characteristics[683]

- coding of body movements or facial expressions involves the development of units that, while easy to see, are difficult to describe adequately by verbal description; VID-R tool for the analysis of motion picture film or video tape "builds a visual dictionary by utilizing the procedures described for temporal reorganization"[684]

- music finder *mufin* which chooses a cluster of songs in the data-bank according to the requested moods (respecting tempo, style, instrumentation and so forth) "[...] und bringt einem Kombinationen, auf die man selbst möglicherweise nie gekommen wäre"[685] - genuin "info-aesthetics", according to which the degree of surprise corresponds with the measure of informative quality[686]

- services ("Apps") like Last.fm learning to detect and then to automatically proposing individual (that is, profiled by predictive analytics) preferences of music; software MusicIP Mixer (as defined by the English Wikipedia) is "a music search machne which uses an algorithm

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[683] For an "open access" data bank to experiment with, see the Freesound Project, and more media-archaeologically the *online* collection of "endangered sounds"

[684] Paul Ekman / Wallace V. Friesen, A Tool for the Analysis of Motion Picture Film or Video Tape, in: American Psychologist, vol. 24, no. 3 (1969), 240-243 (242). See further P. Ekman / W. V. Friesen / T. Taussig, VID-R and SCAN: Tools and methods in the analysis of facial expression and body movement, in: G. Gerbner / O. Holsti / K. Krippendorff / W. Paisley / P. Stone (eds.), Content analysis, New York (Wiley) 1969

[685] A commentator, in: http://blog.magix.com/de/archives/270-Mit-mufin-gibt-es-nur-noch-Lieblingssongs!.htm (accessed 12 May, 2009)

[686] See Helmar Frank, Informationsästhetik. Grundlagenprobleme und erste Anwendung auf die mome pure, 2. Auf. Quickborn (Schnelle) 1968 = Diss. TH Stuttgart 1959; darin Begriff / Maß des "subjektiven Zeitquants"

for generating unique acoustic fingerprints" from which songs can be identified by their genuinely acoustic signature (which, to be precise, is its transformation into digital data) "regardless if dufferebces at the digital data level (file format, data compression rates, etc.)". But still this music analysis technology is oriented at recognizing what is meaningful according to *human* musical attributes

- very term "music" seems almost identical with human, culturally trained listening; musical knowledge (*mousiké epistemé*) though considered as detached, even independent of human listening (like the Platonic "music" of the astronomical spheres). For strictly media-archaeological (that is: machine-based) "ears", this option re-turns

- GAMA (the Gateway to Archives of Media Art) requiring a new art of search engines, allowing for multimedia content search; develop "automatic metadata indexing and video segmentation tools (face detection, motion detection, shot boundaries, representive frame generation) in order to provide fast access and content browsing capabilities"; "advances search facilities (like image query by example, or visual similarity search) combined with key-words to ease the finding of media art items" - to be extended to the underestimated *sonic* dimension - will finally arrive at navigating *within* the digital file

- algorithmic data processing transforming audio archive as passive memory institution to media-active subject of search; search enginge itself becoming an archaeologist of sonic knowledge

- neuro-phenomenological vs. media-archaeological approach to musical cognition; role of analytic research media / algorithms, but digital audio processing itself different from neuronal audio signal transduction; new perspective for Systematic Musicology "which, as a discipline, often sets out to explain or describe music through the induction of empirical laws, regularities or statistical correlations in relation to music objects or music related behaviour"[687]

- "Symbolic formats can be contrasted with audio formats which,
instead of capturing notes explicitly, encode the sonic **<!>** aspect of a musical performance by representing sound as a complex waveform. The best known formats are audio CD, the WAV and AIFF formats used primarily in computers and iPods, and MPEG-1 Audio-Layer 3 (mp3) as a compression format used for web-based and portable applications" = Müllensiefen / Wiggins / Lewis ebd., 133

- corpus-based musicology project, Princeton University: From 1963 to the beginning of the eighties, researchers, led by Arthur Mendel and Lewis Lockwood, generated electronic scholarly editions of the complete works of Josquin, including concordances, and relevant related works. "From this, statistics for cadential progressions and modal indicators were compiled and subjected to statistical analysis primarily in order to study issues of authorship and stemmatic filiation (see <...> various papers in Computers in the Humanities between 1969 and 1978). [...] never extended to revealing cognitive processes, being limited, essentially, to style analysis."[688]

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[687] Daniel Müllensiefen / Geraint Wiggins / David Lewis, High-level feature descriptors and corpus-based musicology: Techniques for modelling music cognition, in: Albrecht Schneider (ed.), Systematic and Comparative Musicology. Concepts, Methods, Findings, Frankfurt am Main et al. (Peter Lang) 2008 (= Hamburger Jahrbuch für Musikwissenschaft 24), 133-153

[688] Muellensiefen et al.: 136

- in folk music research, feature extraction and the Digital Humanities use of computers employed as a means for the (automatic) classification of songs (mainly melodies) according to their musical characteristics. "In a comprehensive study Steinbeck (1982) classified European folk melodies into six homogeneous groups by employing Ward's classification algorithm with 35 relatively simple features derived from the monophonic melodies."[689]

- *what* one can hear *only* distantly, and what requires closeness in order to capture; Axel Roch, "Texte als Bilder über Signale lesen"

Search "within its own medium": Towards content-based retrieval

- technomathematical knowledge; mighty algorithmic tools for "audio fingerprinting"; copyright issue of locating audio content without metadata annotation"; mass-applicable content-based search engine for audio data is firmly implemented in the iPod. Listening to a song, the device can be directed to the sonic source with the menu option "Music is being analyzed", leading to an almost immediate recognition of the song and the option for (paid) downloads

- literal transcription of audiovisual evidence into symbolic notation an asymmetrical transformation, reducing the richness of aesthetic signals to semantic signs. The alternative way (content-based retrieval systems according to the MPEG-7 standards, f. e.) is to retrieve audiovisual evidence *in its own media* (that is, aisthetic regime): "based on audio analysis, it is possible to describe sound or music by its spectral energy distribution, harmonic ratio or fundamental frequency" = Hyoung-Gook Kim / Nicolas Moreau / Thomas Sikora, MPEG-7 Audio and Beyond. Audio Content Indexing and Retrieval, Chichester (John Wiley) 2005, 2, allowing for a comparative classification of sound into general sound categries

- content-based sound retrieval application explicitely offering algorithmic tools "in combination with traditional keyword and text queries" = Blum et al. 1997: 114

- time domain description (by the audio waveform descriptor) as genuine option of multi-media archives, media-archaeologically revealing characteristics of the original signal in its very sonic existence, a phonographic alternative to alphabetic symbolic "elementarisation", that is: analysis

- spectral audio descriptors derived from a single time-frequency analysis of an audio signal = Kim et al. 2005: 6, that is: from within the signal (as sampled into digital values). The media-archaeological ears listens to the endogenic evidence,

- software *audentify* (created by the computer scientist Michael Clausen at the University of Bonn): in this case, digital patterns of music files are being matched against an index; or MusikDNA; audio identification software TRM creates an acoustic fingerprint of the first 30 seconds of a piece of music,kind of *incipit*

- now possible to select or sort or classify sounds from a database using the distance measure; example queries: "Retrieve the `scratchy´ sounds" = ibid., 121

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[689] Muellensiefen et al.: 136

The sonic difference to software for visual content analysis

- analysis algorithms for audio; "the general techniques employed bear some resemblance to non-audio content-based retrieval systems, for example, the Query by Image Content (QBIC) system (Flickner et al. [...])"[690]

- audio signals radically (and essentially) functioning on the time axis; visual regime serves to abbreviate temporal extension, with the image as condensed sound: "Waveform and spectral displays are sometimes useful, but only to the highly trained eye (and ear). Visual displays of the n-dimensional search space [...] would be appropriate for browsers of large sound databases"[691]

Recording sound from the real world

- Barthes describing affective experience of looking at an ancient photography as *punctum* - a short-cut between past and the present: a punctual moment, while in acoustic recording by gramophone there is a processual, time-based signal; its re-play generating a different sense of the past. Ludwig Wittgenstein confessing that when he imagined a tune recorded for a gramophone "this is the most elaborate and exact expression of a feeling of pastness which I can imagine"[692]

- Even if it makes less of a difference in phenomenological (human) perception, sound, when being re-generated out of electro-magnetic latency, embodies a tempor(e)ality different from the almost scriptural engraving in the gramophone groove[693]

- as engraved index (in Peirce's semiotic sense), a sound forming a sharp contrast to its symbolic notation. *Indices* represent their objects "by virtue of being in fact modified by them", in a truly analog way[694]; gramophone groove literally being in-formed by sound, but this is still a material, physical shaping, whereas digital information is no question of matter or energy any more; acoustic signal not losing its temporal indexicality when being recorded: "The sound, taken away from the real event, retains its indexing properties"[695]; aggressive acoustic signal even in its media-technological reproduction retaining its physically *effective* and

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[690] Blum et al. 1997: 114

[691] Blum et al. ibid.

[692] Ludwig Wittgenstein, here quoted after: Gregory Ulmer, Applied Grammatology, Baltimore (John Hopkins University Press) 1985, 110

[693] See Theodor W. Adorno, Die Form der Schallplatte [1934], in: same author, Gesammelte Werke, vol. 19: Musikalische Schriften VI, Frankfurt/M. (Suhrkamp) 1984, 530-523

[694] Charles S. Peirce, Brief an P. E. B. Jourdain [*1908], in: Carolyn Eisele (Hg.), The News Elements of Mathematics, 3/2, Berlin (Mouton) / Atlantic Highlands, NJ (Humanities Press) 1976, 879-888 (887)

[695] Naomi Cumming, The Sonic Self. Musical Subjectivity and Signification, Bloomington / Indianapolis (Indiana University Press) 2000, 90 (unter Bezug auf Charles Sanders Peirces Collected Papers (1.335, 1905)

physiologically *affective* reality, being co-originary in terms of its frequency values

- "schiziphonic" (Schaeffer) effect of sound coming out of loudspeakers from a technical record; response to the real non-narrative signal

- Walter Benjamin identifying kind of "optical unconscious" which reveals itself only to the camera eye; analogous for sonic phenomena: phonographic records unintentionally co-registering a whole world of additional information, starting from background noises; no "message" from the past; Soundscape Project in Vancouver

Media as active archaeologists: SpuBiTo

- real archaeologists of sound past technical measuring media which are able to de-cipher physically real signals techno-analogically, and to represent them in graphic forms alternative to alphabetic writing, requiring "moving" diagrams as sinosuidal articulation in time, such as the oscilloscope

- dis-closure; opto-digital image processing of sound tracks on early Edison cylinders allows for listenting again to otherwise unaccessible sound recording, by a hybrid of mechanical stylus (haptic transitivity) and optical scanning

- below the phono-archival regime, media decoders become active archaeologists of "signals from the past" themselves.

- glyphic voices on the analogue, vulnerable storage medium of wax cylinders are currently being de-freezed by digital means; Berlin Society for Applied Informatics has developed a method to gain acoustic signals from negative traces of galvano-copies from Edison-cylinders by opto-endoscopic „reading“ - scanning its "visual" (glyphic) information into sound.[696] Making stored acoustic waves actually sound does not demand rhetoric imagination but on the contrary a hermeneutically distant gaze, an exteriority of interpretation

- opto-technical scanner only can provide for a distant *aisthesis*; media Archaeology as specific method of "Digital Humanities". Technical media provide a different option of reading: reading without (premature) understanding. The archaeological gaze mimicks this ascetic confrontation of signals, resisting the narrative temptations of figuration

- *Phonogrammarchiv* at Ethnological Museum, Berlin, partly consists of *negatives* of early wax cylinder recordings (copper galvanos) which like Talbot's negative photography require a conversion into positive sound signals again. With such a technical operation (in visual and in audio memory), an attitude to remembrance of the cultural past is trained which differs from historical narrative: negative-to-positive conversion, transforming a latency into manifest re-enactment

- SpuBiTo - From Image to Sound = http://www.gfai.de/english/projects/image-processing-industrial-applications-projects-/spubito.html: "Since the unique galvanos shall not be damaged during the reproduction process the GFaI in co-operation with the Ethnological Museum of Berlin developed an image processing system which is able to retrieve the sound from the

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[696] See Gerd Stanke / Thomas Kessler, in: Simon (ed.) 2000: 209-215

negatives." Positive signals which embody "negative sound" in latency (like subharmonics, the cosinus of the sound wave) are technically *driven* into digital data for further processing. GFaI "[...] designed a 3-axes positioning system with special light sources and an optical / mechanical reading head which can snap images from the inner side of the cylinders where the sound tracks are located. The different axes compensate the geometrical errors of the cylinders and move the optical-mechanical reading head to each position within the cylinder. An image processing algorithm then separates the different tracks and keeps a special diamond stylus in the middle of the tracks."

- central for SpuBiTo = "the height detection algorithm measuring the height of the tracks, computing the movement of the diamond stylus and reconstructing the acoustical information"; media-archaeologically sharpened mind is conscious of the algorithms of which such an animation is a technomathematical, processual function

- system not damaging the unique negatives, therefore allowing for a truly *archival* reading; retrieved sound documents can *directly* be stored on digital media for *secondary* "archiving or processing" <GfaI> - where in fact the archive is coupled to algorithmic manipulation itself, thereby undergoing a complete metamorphosis (from intransitive to transitive) of its traditional state as monumental *stasis* and *distinct* heterotope of the present. "The central part of SpuBiTo is the height detection algorithm measuring the height of the tracks, computing the movement of the diamond stylus and reconstructing the acoustical information" = "SpuBiTo - From Image to Sound"; http://www.gfai.de/english/projects/image-processing-industrial-applications-projects-/spubito.html; German acronym for "Spur - Bild - Ton"

- "sonic analytics" refers to the technological analysis itself (different from the subsequent humanist "cultural analysis" of the resulting audio signal findings)

- *close reading* of sound as image dissolves any continous wave form into discrete blocks, which are accessible for analysis only by operative techno-mathematical diagrams - a media-archaeological deciphering of sound from the past

Acoustic archaeology

- Edison wax cylinders from the beginning of the 20th century containing background recordings of environments that were never entended for memory; within the temporal figure of resonance, an earlier event can recall a later one. What once has been considered as undesirable noises may from a different perspective (or better: hearing) turns out as a kind of acoustic cinema. This leads to the counter-historical idea of simultaneity, the co-existence of two different times, including the now-time of listening (Moore / Kiefer); a different hearing / notion of the sound of the past "based on waves, simultaneous time and shifting soundscapes[697]

- differentiate between the cultural "social" respectively "collective" (Halbwachs) memory of sonic events and the actual (media) recording of sonic articulation from the past. For an archaeology of the acoustic the human auditory sense does not suffice; therefore track the sonic trace with genuine tools of "media studies" which is technological. One way of "acoustic archaeology" is to play a musical score on historic instruments. But the real archaeologists in

[697] See Tony Schwartz, The Responsive Chord, New York 1974 <?>

media archaeology are the media themselves - not mass media (the media of representation), but measuring media which are able to de-cipher physically real signals techno-analogically, and representing them in graphic forms alternative to alphabetic writing, requiring "moving" diagrams (sine sound is articulation in time): the oscilloscope

Case Study: Sound archives

- storage-and-transfer techniques of audio carriers changing from technically extended writing such as analog phonography (as graphical method - with Marey - still in accordance with the recording and representation practice of history as a function of historiography) to calculation (digization); not just another version of the materialities of tradition, but a conceptual change. From that moment on, material tradition is not just function of a linear time base any more (the speed of history), but a new, basically atemporal dimension (acceleration), short-cutting the emphatic time arrow and demanding for a partial differentiation (just like the infinitesimal calculus was introduced by Leibniz as a measure of non-linear change *within* speed).

- accidental sorting of sound and images: between signal-based similarity and symbol-based logocentrism

- "dynamic algorithmic access replacing the static classification of the traditional catalogue; coexistence of different orders without destroying the material structure - *relational* databases and *random search* (familiar in "hashing" in the the administration of computer storage, a kind of *order in fluctuation*. which is the radical temporalization of order itself

Sonic Media Archaeology

- transmitting sonic information to future ages by coding (Carpo on Alberti), allowing for a later re-sonification, not by direct audification (like the phonographic record) but in terms of parameter mapping[698], has been the musical score - depending, though, on a physical "medium" - be it the human voice or the appropriate music instrument - to be re-implemented into the physical world. Another variance is the survival of original instruments from the past which allow not for the exact re-play of every melody which has been produced upon it but at least to re-produce the fidelity of the defining and definite sound spectrum[699]

- media installation *Voice of Sisyphus* under Legrady's artistic direction, methods of "digital archaeology" (operative image analysis) are being used to sonify the image-as-memory itself. A black & white photographic image from the 1970s displaying a hotel scene "At the Bar" is filtered by a computer program which then reads the segments and produces sounds out of them resulting in a continuously evolving composition; no deliberate, but a algorithm-based, rule-based, in Foucauldean terms *archival* transformation; like for digital image compression, an image region is selected, this block then "linearized" and "read" for FFT like a analog TV signal, line by line. Giving a voice to the image; http://vimeo.com/30238729; with sound:

[698] See Thomas Hermann / Andy Hunt / John Neuhoff (eds.), The Sonification Handbook, Berlin (Logos) 2011

[699] "Model-based sonification" as described by Florian Dambois, Sonifikation. Ein Plädoyer, dem naturwissenschaftlichen Verfahren eine kulturhistorische Einschätzung zukommen zu lassen, in: Petra Maria Meyer (ed.), Acoustic turn, Munich (Fink) 2008, 91-100 (92)

http://vimeo.com/34859885; VOICE OF SISYPHUS: AN IMAGE SONIFICATION MULTIMEDIA INSTALLATION presented at The 18th International Conference on Auditory Display (ICAD-2012), June 18–22, 2012, Atlanta, USA; paper: http://www.mat.ucsb.edu/Publications/McGee_ICAD_2012.pdf

- term *archeo-acoustics*; "pre-historic" not in the temporalhistoric but *structural* media-archaeological sense of non-discursive (cultural), rather implicit sound; situation Sirenen expedition

- cultural appearance of acoustic echo, digested as Greek mythologem, re(oc)curring (equi-temporally) by electro-mechanical, technical, afterwards computational means: generative echo resp. reverb, *without bodily source*

- tecsound signal rather than sign; "sonicity" as implicit sound, non-human dimension of sound

- Anthony Hempell, "The Resonating Interval. Exploring ..."; McLuhan differentiating between "pre-" and "post-Euclidean" acoustic space

Electro-acoustic space (McLuhan)

- McLuhan's analysis of the electronic "acoustic space" which he sharply discontinues from the machinic age; in research group around the journal *Explorations* and especially in his *Culture and Communication Seminar* on the campus of the University of Toronto where McLuhan got the term "auditory space" by the psychologist Carl Williams (who himself had it borrowed from E. A. Bott). "The phrase was electrifying. Marshall changed it to 'acoustic space'", the group member Edmund Carpenter remembers[700]

- from the time-critical nature of the electronic image that McLuhan derives his insight into the radically temporal message of hight-technological media: "You are drawn into that tube, as an inner trip. You´re totally involved. You have no objectivity, no distance. And it is acoustic. It resonates. But this is a hidden ground, because superficially people think the´re looking at a visual program. And they´re not. They´re not looking at all - they´re absorbed, involved in a resonating experience"[701]

- "I have never ceased to meditate on the relevance of this acoustic space to an understanding of the simultaneous electric world" = Marshall McLuhan, The end of the work ethic, in: M. A. Moos (ed.), Media research. Technology, art, communication, Amsterdam (G&B Arts International) 1997 [*1973], 92-109 (101). Siehe Michael Darroch, Bridging Urban and Media Studies: Jaqueline Tyrwhitt and the *Eplorations* Group, 1951-1957, in: Canadian Journal of Communication, Bd. 33 (2008), 147-169 (158)

- wave field synthesis; argument was taken up by a pacticing radio journalist, Tony Schwartz in

[700] quoted here after: Michael Darroch, Bridging Urban and Media Studies: Jaqueline Tyrwhitt and the *Eplorations* Group, 1951-1957, in: Canadian Journal of Communication, Bd. 33 (2008), 147-169 (158)

[701] McLuhan im Interview mit Jerry Brown, in: The CoEvolution Quarterly, Winter 1977/78, zitiert in: Letters of Marshall McLuhan, selected and edited by Matie Molinaro / Corinne McLuhan / William Toye, Toronto / Oxford / New York (Oxford UP) 1987, 177

New York, became a professor of auditory perception at Fordham University. In his book *The responsive chord* (Garden City, New York: Anchor books) 1974 (paperback edition; hardcover edition 1973), he writes: "Space, time, the concept of self, etc., take on very different meanings when auditory patterns replace a linear, visual orientation" <8>

- McLuhan, with his "acoustic space" model of the electrical age, remains a nostalgic of the analog signal processing and electro-engineering (circuits, closed circuits, like the early "closed circuit" installations in the video art of his days, such as Nam June Paik and Dan Graham). Ironically enough, the (in all ways) discontinuous digital processing remains hidden even today, where the analog is dominant on the computer interfaces. McLuhan remains with electronic media, not with the symbolic machine (the techno-mathematical paradigm). McLuhan, when referring to the computer, reduces it to an electronic medium - while neglecting its algorithms.

- McLuhan's model rather the analog computer. "Resonance" is his central figure: "Acoustic space is organic and integral, perceived through the simultaneous interplay of all the senses <...> the rich resonance of the tribal echoland"[702]. "Resonanz ist der Modus des akustischen Raums" <McLuhan 2002: 213>

- broadcasting media differing from global communication as Internet, since this is not resonance-based (the electromagnetic waves technology) but topologically, alphanumerically connected (Inrternet protocols) - the return of number, but in disguised form (audiovisual and textual interfaces)

- In its technological and in its neurological sense the processual mode of "electronically mediated human communication" (Schwartz) - a term to be preferred against the simplifying notion of *audio-visual media*[703] - is resonance, reverberations. Not by coincidence Schwartz uses terms which stem from the sonic sphere, since every sonic articualtion is radically time-based (otherwise it does not unfold at all): "In discussing electronically based communication processes, it is very helpful to use auditory terms <...> like *feedback* ... *reverberation* ... *tuning* <...>" = Schwartz 1974: 23; the electronic image (as opposed to the rather mechanical cinematographic frame) is closer to sound (thus to time) than to spatial imagery: "*The image we 'see' on television is never there*" = Schwartz 1974: 14

- Tony Schwartz in *The Responsive Chord* declares on the electroniv TV image: when humans watch TV, their eyes function like ears: "In watching television, our eyes function like our ears" = Schwartz 1974: 14 - an theorem which has been taken over by McLuhan / Powers in *The Global Village* since. "Wenn wir fernsehen, funktionieren unsere Augen wie Ohren": Schwartz, quoted after McLuhan / Powers 1995: 94

- With "telephone, radio, film, records, and television, we developed a stronger orientation toward the auditory mode of receiving and processing information. <...> This was true not only

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[702] Marshall McLuhan, The Playboy Interview: Marshall McLuhan, in: Playboy Magazine, März 1969; Wiederabdruck in: Eric McLuhan / Frank Zingrone (Hg.), The Essential McLuhan, London (Routledge) 1997, 233-269 (*online* www.columbia.edu/~log2/mediablogs/McLuhanPBinterview.htm), as quoted here from: Martina Leeker, Camouflagen des Computers. McLuhan und die Neo-Avantgarden der 1960er Jahre, in: DeKerckhove et al. (eds.) 2008, 345-374 (352)

[703] See Michel Chion, Audio-Vision. Sound on Screen, New York / Chicester (Columbia UP) 1994 [Frz. Orig. L'Audio-Vision, Paris (Nathan) 1990

for sound, but also for electronically mediated visual information, which is patterned like auditory information" = Schwartz 1974: 13

Articulation in "sonic" time: resonances

- Ars Electronica Festival in Linz, Bill Fontana, "Golden Nica" (category of Digital Musics) for his acoustic deconstruction of the bells of Big Ben in London unter the title *Speeds of Time* = http://resoundings.org: Electronic sensors on the clock menchanism and microphones close to the bell generate spatio-acoustic composition which is played close to Big Ben itself; the manipulated, artificially calculated sound of the Bells interacts with the "natural" ringing of the bells. A *Schwebung*, an interference of these two acoustic spheres, results in a third tonality, which has been recorded by multitrack technology within the interval of 12 hours, to be re-installed in the art festival context; can be replayed in real-time, thus invariant to the delay in physical, "historic" time which has elapsed between the recording time and the time of reenactment

- McLuhan insisting that electricity is of the same nature than the acoustic world in its being everywhere simultaneous; cp. ray-tracing: "When trying to predict the reverberation time of specific designs, most architects throughout the nineteenth century relied on the notion of 'sound beams' (Schallstrahlen) and on laws of reflection borrowed from optics. The behavior of sound in different auditoriums could thus be graphically simulated [...]. [...] some theater architects began to respond to the new definitions of sound by physicists - who had come to understand it as a time- and medium-dependent periodic fluctuation in pressure [...]" = Viktoria Tkaczyk, The Shot Is Fired Unheard: Sigmund Exner and the Physiology of Reverberation, in: Grey Room 60, Sommer 2015, 66-81

- although not found in nature, sine wave useful for demonstrating the basis features of sound waves. "Like other wave phonema, sound wave can be described in terms of four characteristics: *waveform* <...>, *frequency* <...>, *amplitude* <...> and *phase*. Because the frequency of sound waves is within the range of nerve cell signaling (at least of low frequencies), the auditory system can use this information directly in responding to sound stimuli; in vision, the frequencies of light waves are many orders of magnitude greater, and the response to frequency is only indirect via the energy content of different frequencies" = Purves (ed.) 2008: 153

- by nature (*physis*), sound waves belonging to the mechanical world, while light is within the range of the electro-magnetic spectrum, thus being a completely different quality; visual perception is the only "radio" organ humans are provided with, while ears cannot listen to radio (in its technical, Hertzean sense) at all, just in translation (by loudspeakters); still, sound waves and light converging in their common analysis as periodic events, counted in frequencies (undoing the material difference in the symbolic mathematical regime), like the earliest devices to create optical illusions of movement like William George Horner's Zoetrope have their predecessors in the study of acoustic oscillations and Ernst Florens Chladni's famous visualizations of such sound figures in 1787[704]

[704] See Daniel Gethmann, Zauberscheiben und Schwingungsverhältnisse. Simon Stampfer, Félix Savart und die Erfindung der stroboskipischen Methode, in: same author / Christoph B. Schulz (eds), Apparaturen bewegter Bilder, Münser (LIT Verlag) 2006, 51-79 (60f)

Reverberative space

- reverberative ("sonic") memory against archival (symbolical) order

- Rupert Sheldrake, The Presence of the Past: A theory of evolution, not based on historical development but on electro-magnetic resonance

- "video as a virtual image" discovered in its "vibrational acoustic character" = Viola 1990: 44; "optophonic" transfer, audio-visual metonymy; media-archaeologically justified: "Technologically, video has evolved out of sound (the electromagnetic) and its close association with cinema is misleading since film and its grandparent, the photographic process, are members of a completely different branch of the genealogical tree (the mechanical / chemical)" = ibid.

- John Logie Baird's "Phonovision" with 30 lines image and frame repetition frequency of 12,5 secs.; such electric one-dimensional signals, when coupled with loudspreaker, still within human audible range; suggested association with sound regording (gramophone), resulting in storage of TV lines on shellack discs. Sequential imagery is transformed into sonic time; both waveforms. Different from cinematography, elektronic television "analyses" the image itself. But the media archaeological core element of electronic image transmission, the scanning and transduction of light signals by selenium or photo cells (and reverse), re-enters into sound film, as *Lichttonverfahren* - which is "television" within film as hybrid, with its alien electronic momentum attached to the otherwise purely mechanical projections apparatus

- video artist Bill Viola subsuming the sonic nature of the electronic image as "the sound of one-line scanning". The video camera, as an electronic transducer of physical energy <light> into electrical impulses, bears a closer original relation to the microphone than to the film camera" <Viola 1990: 44>

- "Western music builds things up" = Viola 1990: 46, synthetically, and it its accordingly measured by Fourier analysis. "It is additive: its base is silence <...>. Indian music <...> begins from sound. It is subtractive"; electro-aesthetics of electro-acoustic synthesizer

- acoustic delay (the echo effect) inducing Aristotle to discover the "medium" of a category in itself, the "inbetween" (*to metaxy*); Emmanuel Alloa, Metaxu. Figures de la médialité chez Aristote, in: Revue de Métaphysique et de Morale, vol.106, Heft 2 (2009), 247-262

- ultrasound itself sort of dynamic memory (in suspense), applied in early computing for short-time intermediary storage of data represented by impulses: "Because the pulses travelled at the speed of sound, they were not only sorted in space but in time, too. The distance from one crystal to the other and the time that the wave took to traverse this distance provided the basic beat. In addition a clock drove the line so that symbols could be positioned within the flow of time."[705]

Still "sound"? The digitizing auf analogue audio carriers

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[705] David Link, There Must Be an Angel. On the Beginnings of the Arithmetics of Rays, in: Siegfried Zielinski / ders. (Hg.), Variantology 2. On Deep Time Relations of Arts, Sciences and Technologies, Köln (Walther König) 200xxx, 15-42 (30)

- Technical Committee of the IASA in its standard recommendations from December 2005: digitization of analogue sound carriers from the past does not necessarily mean a loss of information about the signal, but can in fact grasp the physical signal as information much more precisely than former analog recording where non-linear distortions of the signal in the process of technological transcription from one analog medium to another takes place (esp. for some frequency bands); Nyquist / Shannon sampling theoreme already allowing that with a sufficient rate the original signal can be truly reconstructed; for archival needs a radical over-sampling up to 192 kHz does not keep the blunt sound information, but the memory of noise (scratches) as well = http://www.iasa-web.org/IASA TC03/ IASATC03.pdf

- "Message or bruit? = Michel Foucault, Botschaft oder Rauschen?, übers. Friedrich Kittler, in: Botschaften der Macht. Der Foucault-Reader. Diskurs und Macht, Stuttgart (DVA) 1999, 140-144. FO (1966): Message ou bruit?, in: ders., Dits et Écrits I, Paris 1994, 557-560

- opto-digital reading of otherwise unaccessible sound recording; "Spektrogramm einer rekonstruierten Tonaufnahme (Wedda-Gesang, Ceylon 1907)" on SpuBiTo web page

A *media* archaeology of the acoustic

- tracking the sonic trace with technical media; "archaeologists" in media archaeology are the measuring media, able to de-cipher physically real signals techno-analogically, and representing them in graphic forms alternative to alphabetic writing, requiring "moving" diagrams (sine sound is articulation in time): the oscilloscope

Architectural sonicity

- Digital Signal Processing and computer-based tools like wave field synthesis (which media-archaeologically recaptures Christiaan Huyghens's approach to the nature of sound propagation) and other technical dispositives allowing for the virtual (which is: counted) reconstruction of "historic" acoustic spaces

- digitally *render back* the acoustics of architectural spaces, such as the dramatic sound within the Palladio theatre in Vicenza (Weinzierl / Sanvito) or the ancient Greek theatres; auralisation; site-specifity, previously been "measured" and explored with acoustic signals (spatial impulse responses ["Impulsantwort"], echoes to be folded upon each other ("rec 21"). Each space which is being displayed acoustically is very site-specific because of the unique acoustic features of each historical piece of (ruined) architecture; certain frequencies are emphasized or vanish as they resonate in space. Space can not be exerienced as "historical" aurally, since by definition sonic articulation perishes the moment it is being expressed; Hegel's argument: "So ist der Ton eine Äußerlichkeit, welche sich in ihrem Entstehen durch ihr Dasein selbst wieder nichtet und an sich selbst verschwindet"[706]; acoustic archaeology retrieving the memory of sound out of architectural spaces; Weinzierl

- for *musique concrète* in Paris, Pierre Schaeffer, defining the "acousmatic" as "sound that one

[706] Georg Wilhelm Friedrich Hegel, Vorlesungen über die Ästhetik III, in: Werke vol. 15, Frankfurt/M. 1970, 134f

hears without seeing the causes behind it"[707], he re-used a term once coined to describe the teaching method of Pythagoras who concentrated ("heated up", in McLuhan's terms) on the human audio channel of communication by hiding behind a veil while speaking - pure, (visually) disembodied voice, grammophone *avant la lettre*

- Weinzierl, audio-spheric reconstruction of Bruxelles World Fair le Corbusier / Xenakis pavillon with *Poème Électronique* by Edgar Varèse

- implicit sonicity on architectural silence, a kind of sounding in latency, like a Gothic cathedral waiting for the organ to fill it with acoustic reverberations; composers of organ music actually creating works with respect to the echo (reverberations / resonances) created by the individual cathedral architecture? Architectural space adds "media" *time* to the symbolic musical notation

- phonetic articulation time-critial itself, very precisely "logocentristic": Verständlichkeit der Sprache leidet erst bei übergroßer Nachhallzeit (mehr als 4,5 oder 5,5 s)[708]

- 3D-SketchUp-Modell or AutoCAD file; on that data basis, with EASE 3D-computer models, in room-acoustic simulations can be experimentally mapped

- in room acoustics, "Mensch bleibt der Maßstab" = http://www.oberlinger-architekten.de/profil_text.htm); alternatively analyze room-acoustic "communication" between organ tone and architectural frame. Organ itself, as dispositive / *Gestell*, as apparatus, an architectonic *organon*; notion of "computing architecture"

- silence itself becoming part of the archive; software for sound analysis *Audacity* actually providing an algorithm called "Silence Finder"

- actual sound from the media-archaeological archive. When an ancient "Datassette" is being loaded from external tape memory into the ROM of a Commodore 64 computer, actually listening to data music, not sound as memory content like an old persussion-assisted song[709], but rather the sound of computer memory itself, that is: a software program which is "scripture" (though in the alphanumeric mode); data archive not sonic memory but inherent sonicity

A new way of experiencing the sonicity of computer-architectural space

- "In bounded spaces, reflected sound folding over on itself cretes resonant nodes that cause spaces to act as filters, nonlinearly amplifying some frequencies and damping others. We

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[707] Pierre Schaeffer, Traité des objets musicaux, Paris (Seuil) 1966, 91. See the entry "Acousmatic sound" in: http://en.wikipedia.org/wiki/Acousmatic_sound (4th June 2011)

[708] "Diözese Rottenburg-Stuttgart / Kirchliches Bauen. Die Kirche als Verkündigungsort. sprechen - singen - musizieren, Abschnitt "Akustik"; http://www.amt-fuer-kirchenmusik.de/Inhalt/Orgel/Orgel_und_Kirchenrenovierung/Orgel-und-Raumakustik_Kirchliches_Bauen.pdf; accessed 14 September 2014

[709] On the interplay between technical memory and affective remembrance see Ben Anderson, Recorded music and practices of remembering, in: Social and Cultural Geography, vol. 5, No. 1, March 2004, 3-19

never hear a sounding object by itself, always an assemblage of sounding object and resonant space."[710]

- different kind of "machine" is at work here: "Acoustic resonance is a subset of mechanical resonance"[711]

- in architecture, reverberative time (the audio signal delay known as "echo"); "no mention of *intentionally* creating reverberation for its theological relevance" = Barry Blesser / Linda-Ruth Salter, Ancient Acoustic Spaces, in: The Sound Studies Reader, edited by Jonathan Sterne, London / New York (Routledge) 2012, 186-196 (195); long reverberation created in huge cathedrals does not as such correspond with the Pythagorean epistemology of harmony based on integer numbers which are infinitesimally broken by acoustic delay time. Such cathedrals - when still existing - are rather involuntary memories of past soundscapes, thus being time machines

- space explored by time-critical sound operations; the engineering of room acoustics by measuring operations such as pulse-response (developed by Walter Sabine around 1900) has even been extended to auralization as re-enactment of the sonic past[712]

- concept of using the building as an instrument: Alvin Lucier; takes the memory capacity of an electronic device to provide fugitive sound articulation with a recurrent index of temporal depth; an initial acoustic articulation expressed in a closed room and is phenomena being recorded; recording is played back into the room, re-recording it; operation known from echo delay by magnetic tape players; exploring a closed architectural space by means of acoustic pulses, signals folded upon themselves; second signal is a replica of the same information delivered within a temporal interval; space itself becoming a function of temporal measuring; spatial and acoustic etension time-critically falling apart[713]; transfer this sonic analysis from concrete architecture into the "flat" and condensed architecture of digital computing

- essence of digital computing the *temporalization of mathematics* by media-operative algorithms; change the sensational mode from the visual to the auditory mode which is the (substitutional) "time organ" in human senses

Symbolic *versus* technological recording of sound

- "tracing" ancient sound recording identifying the vibrational groove; signal recording, not symbolic notation; in digital sound processing, the symbolical returns: on a dynamical, time-discrete level, essentially closer to the nature of acoustic impulse trains

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[710] Peter Price, Resonance. Philosophy for Sonic Art, New York / Dresden (Atropos Press) 2011, 20

[711] Price 2011: 21

[712] As an exemplary study see Stefan Weinzierl, Beethovens Konzerträume. Raumakustik und symphonische Aufführungspraxis an der Schwelle zum modernen Konzertwesen, Frankfurt/M. (Erwin Bochinsky Verlag) 2002

[713] As has been analyzed by Michel Chion, Audio-Vision. Sound on Screen, Columbia UP 1994

- implicit musicality within the computer: the rhythm of algorithms. In order to become operative in the real world, mathematical algorithms (which symbolically exist as source code lines, that is: a form of alphanumerical text) have to be implemented into real physics, usually electronic elements, to be endowed with temporal agency.

- BBC World Service launching the "Save our Sounds" project, looking to "archivize" unique sounds (different from reproducable records) that may soon be lost; sound compressing and filing algorithm which rules the process of sound provenience to permanent storage

- the pre-emptive archive: bias (cultural recording projects under the temporal perspective of "future in the past") pre-dated by the Berlin Phonogram Archive past 1900 (Erich Moritz von Hornbostel) for ethnological music (that is, acoustic recordings across endangered cultures); Albert Kahn's photographic and cinematographic Archives de la Planète in Paris; Paula Amad, Counter-Archive. Film, the Everyday, and Albert Kahn's Archives des la Planète, New York / Chichester (Columbia University Press) 2010, esp. 153: phonographic inspiration of Kahn's project: Archives de la Parole, foundet by the linguist Ferdinand Brunot in 1911 at Sorbonne university in Paris

Sonic arts / acoustic archaeology

- by opto-digital reading of early Edison cylinders listenting again to otherwise unaccessible sound recording; the opto-digital *close reading* of sound as image, accessible for human analysis only by operative techno-mathematical diagrams: spectrogram of reconstructed recording (Wedda chant, Ceylon 1907) on the SpuBiTo web page

- installation *The Physical Value of Sound* by Yuri Suzuki <www.yurisuzuki.com> at the media arts festival Ars Electronica in Linz, September 2009 explicitely based on the electro-mechanics of (manipulating) records (their speed) and pick-up systems (their non-linear use)

- micro-physical *close reading* of sound, where the materiality of the recording medium itself becomes poetical; light-based sound inscription in early film

Kurenniemi-as-archive: Resistance against the biographical impulse

- http://www.constantvzw.org/site/Online-Archive-Erkki-Kurenniemi-In.html

- some of Kurenniemi's digitally addressable electronic music instruments (the DIMI series, even akronymically comparable with what is known today as the Musical Instrument Digital Interface software MIDI) deposited in the Electronic Music Studio (since 1971) of the University of Helsinki Musicology Department where it is intended to make them accessible for re-play / technological; operative re-enactment

- historians of technology traditionally using textual documents rather than artifacts in their archival reconstructions of the past = Christian Sichau, Die Replikationsmethode: Zur Rekonstruktion historischer Experimente, in: P. Heering / F. Rieß / same author. (ed.), Im Labor der Physikgeschichte. Zur Untersuchung historischer Experimentalpraxis, Oldenburg (Bibliotheks- und Informationssystem der Universität Oldeburg) 2000, 9-70 (9) not miss this opportunity for a different kind of "sources" in the case of Kurenniemi's synthesizers. In order to have them as an active archive, different from textual and audio-visual data which can be

read, heard and seen, this electronic hardware itself must be kept running in order to prevent its simple historicizing and musealizing. When an electronic image on a cathode ray monitor transmits an event, the date of the event or the fabrication year of the device do not matter.; only switched-off TV set can be a "historical" (museum) object

- Thomas Wilfred's visual music named *lumina* and his color organs *Clavilux*, played by keyboard. Wilfred's objections to recording Lumia works on film (in his writings collected in *Thomas Wilfred's Clavilux*)[714], making the survival of his works dependent on the re-enactability, i. e. the material existence of his machines (now mostly in the Epstein Collection[715]

- written records, once deciphered, re-activated by reading them literally; a techno-logical artefact in need to be in operation to be understood as medium. On the one hand, there is the archival imperative not to be invasive to the document or museum object. Thus one of the remaining options is to materially re-build or logically emulate the integrated synthesizer. There are the archive's two bodies: its material authority (to be kept intact), and is virtual "liveness"

Kurenniemi's "musical" techno-mathematics

- paradigm of electronic music (studios and composing, such as Pierre Schaeffer's *musique concrète*) has been tape recording and tape editing; in contrast, Kurenniemi developed digital sound and image control technologies.

- technological things embodying an epistemological implicit value that deserves to be expressed

- hermeneutics looking at an author's (collected) works, while discourse analysis investigates the Kantean *a priori*, the conditions which made such articulations possible at all, the systems, the rules which make the appearances and articulations. This *dispositif* (apparatus) is technical when it comes to media culture; Kurenniemi's electronic circuits (and in equivalence his own mathemacial theory of musical harmonics-in-time) part of a textuality which can not be expressed by historiography and narrative but rather by the *diagrammatic archive*

- cybernetic fascination with bio-feedback and bio-musical compositions, influenced by Eaton

- "If the images of technology cannot be shown, - and perhaps this is a blessing rather than a tragedy - what can be shown are the relationships" = E. K. (In 2048); diagram

How does one become archive?

- Kurenniemi's obsessive self-recording (starting with his audio tape and video diaries) meant to be orchestrated in a "re-run of his life"[716] on July 10, 2048, on occasion of his 107th anniversary; the real archive of a "techno-visionary" (Huhtamo) such as Kurenniemi is his

[714] Borgo Press 2006

[715] Entry Thomas Wilfred in the online encyclopedia *Wikipedia*; http://en.wikipedia.org (accessed April 2013; last modified 23 March 2013)

electronic devices which are not body-related but mind-related embodiments of his thoughts; Kurenniemi's synthesizers *are* archives themselves already: their blueprints and diagrams, and Kurenniemi's design for new musical scores, that is: the symbolical (archival) order. But the novelty of electro-technological media inscribed itself into cultural memory by using signals instead of symbols; *sound* of Kurenniemi's synthesizers, the articulation of the medium as sonic memory worth of tradition - in fact, the technological witness; recordings of the Silbermann organ at Freiberg cathedral in times of the GDR stating record label ETERNA preserve how the organ sounded in the 1980s

- "operative diagrammatics" understanding techno-logical objects as materiality and algorithms in action; what Kurenniemi's film *Electronics in the World of Tomorrow* shows.

- regarding technical apparatuses through the approach of an engineer - a specialist in the diagrammatics of circuits, and thus the diagram becomes what could be described as a “literal crossing-point between epistemologically wired humanities analysis of technical media and the engineering enabled understanding of and tinkering with operationally."[717] It is through the diagram that temporality - or time-criticality- is being executed on the various micro levels of technology; humans operate through the diagrams of the machine.[718]

- diagram not simply something inserted into the machine, but generating it through its operation. "The operative diagram is the machine in motion, understood from the time-critical, micro-temporal point of view. In fact, is it the implementation of the symbolical order (the archive) into the electro-technically real (hardware)" = Jussi Parikka, Operative Media Archaeology: Wolfgang Ernst’s Materialist Media Diagrammatics. Theory, Culture & Society, vol. 28, no. 5 (2011), 52-74 (66); this diagram which deserves and demands the archive.

- not simply turn Kurenniemi's live into a "multimedia database" (Huhtamo), transforming into a virtual databody, but remember his hardware embodiments as well; his memory and after-live implemented in the wiring, diagrams and programs of his electroacoustic instruments

- Dimi-0 (1971) based on an optical interface, the original pourpose of which was to read sheet music graphically like Iannis Xenakis' UPIC system

- Dimi-O instrument can also be played with a conventional keyboard - the content of a new medium tends to be the previsous one as a re-mediative concession to the user -, or via a video camera. Somewhat in alliance with Lev Theremin's interactive radio-instruments like the *Terpsion*,

- such instruments truly media-archaeological not only in the sense of "earliest electronic musical instruments" = Ojanen et al. 2007: 92, but in their aesthetic archaism, reducing form to the essential hardware function as proto-typal aesthetics

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[716] As expressed by Errki Huhtamo, Kurenniemi, or the Life and Times of a Techno-Visionary, *online* http://d13.documenta.de/panorama/#/research/view/kurenniemi-or-the-life-and-time-of-a-techno-visionary; accessed 19 Oktober, 2012

[717] Parikka, 2011b, p. 65

[718] Parikka, 2011b, p. 65

- Erkki Kurenniemi's Film *Electronics in the World of Tomorrow* [719]
shows cable spaghetti, integrated circuitry - analog until digital. Close to the actual electronics, visualle accompanied and superposed by light patterns created by the very machine which is "dissected" (DIMI synthesizer)

Transparency of the circuit diagram instead of user-friendly interface metaphors (case Kurenniemi)

- electro-mechanical Fender Rhodes Piano originally developed by Harold Rhodes as a transportable substitute piano; substitutional mechanism with all its deficiencies compared to the sound of the fully acoustic piano resulting a sonic aesthetics of its own. The keys strike tuning falks tighly coupled with a resonanting Tonebar, with the tone itself being picked up by a magnetic device like with an electric guitar

- Digital Signal Processing and Physical Modeling of acoustic instruments; any "e"-instrument electro-magnetically transsubstantiating (technical term in Christian liturgy) the essence of sound from mechanical vibration into an essentially completely different, but mathematically analogue form of existence - from sound to sonicity

- Kurenniemi's device DIMI-O employs a video camera for opto-phonical signal input allows for a keyboard interface. DIMI-O includes a memory unit with a 32-step sequencer, with the memory locations being presented on a television screen from which the player can read the contens of the memory. "A cursor running over the screen tells which location is played at the moment" = Ojanen 2007: 91

- Kurenniemi furthermore designed instruments based on bio-feedback reflecting the cybernetic paradigm, f. e. 'Dimi-S (known as Sexophone, 1972), "wheresound genration is based on the electric conductivity of the skin, and 'Dimi-T (aka Electroencephalophone, 1973), where the sound control is based on a signal generated by the electric activity of the brain" = Wikipedia, accessed November 2012; DIMI-T brain wave sonficator: Kurennie's draft design (and minimal circuit) for that device; *a priori* of such fabrications is electrophysiology; "cat microphone"; based upon signal processing, *not* the symbolical order

Signal analysis instead of symbolical notations: Kittler's synthesizer modules

- alternative to the symbolic order (in the sense of alphabetic records and their archival tectonics) is signal-based memory such as the phonographic record of voices and music.

- sound that is stored *inside* technology, inaudible for human ears. An analog signal recording in an Edison phonograph cylinder contains physical traces of the past, but a Nintendo "Game and Watch" handheld electronic game from 1981 also does: its electronic circuitry, its ICs and its loudspeaker enable to experiment analytically, algorithmically recreating the same auditive events that the device would have produced when it was first sold; experimental listening to the *audible past* [Sterne 2003], making it imperative to work with the original hardware versions of the electronic toys under discussion

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[719] http://ubuweb.com/film/kur.html; http://www.ubuweb.com/film/kur_electronics.html

- Kittler's code, written in Assembler on the hard disc drive of his personal computer, must be kept running - not be performed by a book which can document but not compile a source code; fig. in Kittler 2006 *Aphrodite*, 300 ff. (on recursive functions)

- Kittler's modular synthesizer and his computer hard drive, when simply put into an archival storage shelf, can not be analyzed like reading a traditional archival record. It rather demands for a kind of vivisection - which means, not just de-constructing its electronics in inert state, but to set it under currency, under voltage, in a running platform again: not just material, but processual philology, an exegesis of Kittler's thoughts by circuit grammatology or rather: operative diagrammatics

- Jan-Peter E.R. Sonntag, photo cycle "apparatus operandi - Anatomie" (2012/13). Structure analysis of the primary VCO circuit board of the basis cube; conceptual art project in different formats, argumenting media-archaeologically, with hardware close to the process, oriented at its performative essence

- for electro-acoustically generated signals, the re-animation of a "dormant" (German: "still-liegenden") modular synthesizer - either by re-informing the original hardware, or (for curatorial reasons respecting the un-changable "original" - not even exchange of rotten condensors) by constructing a replica, or virtually (that is: algorithmically) within the programming platform SuperCollider

- among Kittler's "archived" source codes, one for generating a sinus tone; like a musical score this can be literally "interpreted" by a computer at any time, while re-activating his modular synthesizer allows for the experiencing the sonic uniqueness of the technical artefact - its *temp/aural* individual articulation - a non-historical mode of re-presencing: dynamic primordiality; "equitemporality" (German "Gleichursprünglichkeit"), known from the concept of "historically informed performance" in re-staging music from the past which is a kind of operative historicism. It is "contextual" not in the classical sense of historical research which reduces the context to the ensemble of available textual records in the period archive, but this time the materiality is the context itself: the apparatus in operation, Kurenniemi's second body much more alive than any archival data recorded on hard disc[720]

Electrolytical recording of "touch and tone" in piano play: Welte-Mignon

- discrete piano keyboard, combined with the "analog" dynamics of the player's touch, results in a hybrid sound mechanism

- in 1926, Emil Schilling's patent for a "Steuerungsvorrichtung für Rechenmaschinen"; retrospectively turns out as a precursor of programmable computing "im Geiste des automatischen Klaviers" (Ralf Bülow)

- piano play still an artistic technique, with the *Pianola* automaton it turns into media art:

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[720] See Peter Heering / Falk Rieß / Christian Sichau (eds.), Im Labor der Physikgeschichte. Zur Untersuchung historischer Experimentalpraxis, Oldenburg (Bibliotheks- und Informationssytsem) 2000, esp. 9-23 (on textual vs. artifactual evidence), and 142 (on the ideosyncracies of the experimental setting ("Eigendynamik"), and *eigenzeit*

"Kunsttechnik wird zur Technikkunst."[721]

- Welte-piano rolls for pianos driven by folded strips or rolls of paper with indendation since 1904 resulted from a mechanical apparatus for the notation of contingent individual musical articulation, providing for identical re-play not only of piano key on/off (like in MIDI) but tempo and dynamics as well.[722]

- Welte-Mignon an analog-discrete hybrid. Designed in 1904 to capture the "temporally dynamic sound of an interpretation" (Stern 2004: 67), a piano containing a recording machine rolled out paper; whenever a note was struck it drew a line on the paper; thereby the individual play could be faithfully recorded in their temporal style as the real message of intepretation from muscial score. "Afterwards, the lines that the notes made while the artist was playing were cut out, leaving an indented paper that could be played back on a specially adapted player piano and produce a replica of the actual interpretation, with all the vitality affects characteristic of the performer."[723]

- Welte-Mignon almost co-originary to the phonograph; this is no coincidence in cultural history, but embodies two originary epistemological alternatives. Phonographic record can replay the acoustic event, not its production in the machine (piano) itself.

- Gustav Mahler, Ferruccio Busoni, Claude Debussy, joung Vladimir Horowitz "verewigten sich" on piano rolls of Freiburg company M. Welte & Söhne (production between 1904 and 1932), like a "frozen" performance; *via* a complex mechanics special reproduction pianos and -organs "reading" the information punched into the paper rolls, and the keys on the player piano move like from a invisible hands ("wie von Geisterhand")

Player Piano / piano player (Welte-Mignon / Glenn Gould)

- Welte-Mignon reco(r)ding oscillating as hybrid between analog and digital signal transduction / processing

https://www.hkb.bfh.ch/de/forschung/forschungsschwerpunkte/fspinterpretation/wievongeisterhand (c/o Roman Brotbeck, project 2007/08)

- mechanism actually liberated piano play from the human hand - just like Henry Fox Talbot, as expressed in his book *Pencil of Nature* (1844), celebrated his invention of negative photography as liberating the self-imaging of nature from the idiosyncacies of the painterly hand. This is an ultimate escalation of the pianist individual dedication to the machine.

- Glenn Gould notablly preferring performance in the electronic studio to live recording in the concert hall, for its productional (not only post-productional) options of analytic manipulation; in his interview by Tim Page for *Piano Quartely* (autumn 1981), Gould celebrates that

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[721] Arno Reinfrank, from his poem on the *Pionala*, in: Bilder einer schrägen Welt. Poesie der Fakten 9, Rohrbach (Peter Guhl) 1996

[722] See Gottschewski 1996: 26 ff.

[723] Daniel N. Stern, The Present Moment in Psychotherapy, New York / London (Norton) 2004, 67, referring to Benhôte, 1972

technology has made the live concert superfluous, since it creates a "climate of anonymity" which liberates the artists from his performative restrictions like nerve reactions and finger restrictions towards an improved aesthetic enunciation, eliminating the contingencies of an actual concert. The core operation of post-performative studio recording and editing has been the magnetic tape splice and cutting of "tape segments varying in duration upward from one tentieth of a second", that is: below the human hearing threshold of a continuous tone. This is not a completely "dehumanizing technique" (as criticized by the "antirecord lobby"), but rather a "schizophonia" (Schaffer) of a different kind, since here "inevitably [...] the functions of the performer and of the tape editor begin to overlap - which for the subsequent listener can not be neg-entropically differentiated any more, just as in montage cinema.[724]

Punched piano rolls and the "digital"

- Musicology at Hochschule der Künste in Bern (HKB), research project (2010/2011) "Recording the Soul of Piano Playing" (c/o Kai Köpp) = https://www.hkb.bfh.ch/de/forschung/forschungsschwerpunkte/fspinterpretation/recordingsoulpiano; current digitizing of the "soul" of Welte-piano music rolls achieved by a scanner, which is in fact a second order digitization of a previous binary coding: punched hole / non-hole, providing to "telegraphic" access to music as performed by a pianist in the past

- digitization conversion of such data into MIDI files and / or archiving them as raw data, inducing new options of algorithmic reserach into historical interpretation such as micro-timing

- non-invasive replay allowing for separating the archival (authentic) materiality of Welte rolls from its binary information

- Welte-Mignon system a non-historical time-tunneling back to early 20th century piano play; the discrete recording of piano key touch and the interpreter's dynamics results in communication between musical performance culture around 1900 and contemporary re-enactment in terms of communication engineering itself (Shannon 1948).

- punched piano rolls "digital" recording *avant la lettre*; but no algorithmic processing (non-recursive)

"Musical" micro-timing

- Richard Beaudoin, The Principles of Microtiming and Musical Photorealism, manuscript http://nrs.harvard.edu/urn-3:HUL.InstRepos:3415685

- since 2009, aided by colleagues Hochschule Luzern, Beaudoin composing notated, acoustic works based on millisecond-faithful *transcriptions* of recorded performances = temporeal transcription; 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 = idem / xxx Kania, A Musical Photograph ?, in: *Journal of Aesthetics and Art Criticism*; millisecond-level measurements of sound unfolding through time.

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[724] Glenn Gould, The Prospects of Recording [from: High Fidelity (April 1966)], in: Tim Page (ed.), The Glenn Gould Reader, New York (Alfred A. Knopf) 1984, 331-353 (337 and 339)

Composing with microtiming beginning by taking millisecond-level measurements of the rhythm in a recorded performance. Based on these proportions, a transcription of the sounds into music notation can then be made. This new musical object can then be manipulated, reorganized and otherwise altered, and new music can be composed above, below, before, after, and inside the source (a contemporary echo of Medieval and Renaissance cantus firmus techniques); links to painting and photography, where an artist captures and transforms existing objects in a new medium = http://www.richardbeaudoin.com/microtiming; time-critical studies

Piano (re-)play: a cybernetic approach

- with Welte-Mignon encoding, "historically-informed performance" becoming informational. The Welte-Mignon piano play recording on punched paper rolls and their re-play oscillates between the human and machinic interpreter. "I have just heard myself playing"[725], Rachmaninov proclaimed in 1923 immediately after hearing his recording from a Welte-Piano roll - a time-delayed acoustic mirror

- "cybernetic" approach to "historically informed music performance" which treats the human-piano configuration as tight / loose coupling, between medium and form (Fritz Heider), to a system, just like the pilot in the airplane, together with the instruments in the cockpit, results in a human-nonhuman communication system, accessible to "harmonic" (Wiener) or stochastic (Shannon / Bode) analysis of human behaviour and limits of physical mechanics. The instrumental piano, as mechanism with a discrete keyboard input, pre-determines the range of human expressions; as a technology, it remains invariant against "historic" (mental, cultural) change for ages

- "historical" interpretation just one (narrative, discursive) parameter of re-enacting the past, which only symbolically refers to time - while in signal analysis, the time objects actually happen

- analog/digital difference between punched card mechanical notation (discrete, "digital") vs. continuous time-varying recording (wave form).

- re-enacting ancient hardware from music museum instruments; http://www.sim.spk-berlin.de/aus_dem_depot_1667.html

- media-archaeologically informed, *operative* performance: automata themselves become the "player" in time-invariant behaviour, as derived from medieval Arabic musical automata and the escapement-driven clock: re-producing time itself[726]

Transcribing machine "music"

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[725] Quoted from: Allen Feldman, Der menschliche Touch. Zu einer historischen Anthropologie und Traumanalyse von selbsttätigen Instrumenten, in: Gabriele Brandstetter (ed.), stress. ReMembering the Body, Ostfildern-Ruit (Hatje Cantz) 2000, 224-259

[726] See Shintaro Miyazaki, *algorithmisiert*, 2012

- Conlon Nancarrow creating "computational", original compositions for player piano which is not derived from recording human play any more like Paul Hindemith's originary compositions for gramophone, or Moholy Nagy's immediate scratching sound on film. Player Piano no "dead medium" which has been displaced by phonographic signal-recording; in a different sense of sonic media archaeology, re-activated device, "[...] um neuartige kompositorische Ideen unabhängig vom Leistungsvermögen von Interpreten zu entwickeln und sie gleichzeitig so präzise wie gewünscht auszuführen" = Moniko Fürst-Heidtmann, Booklet zur Compact Disk Conlon Nancarrow, *Studies and Solos*, Wergo: WER 66702, p. 3

- turning the notion of "historically informed interpretation" upside down, two female pianists, in kind of *reverse media archaeology,* "humanising" Nancarrow's compositions in four-hands play

- Norwegean composer Christian Blom's record of Lyrical Pieces, based on Grieg's lyrical pieces and initially on the Schmetterling which he himself recorded on a Welte-Mignon piano. Spencer Chase's collection of music recorded on Welte-Mignon; makes MIDI files for sale. In 2007, 100 years after Griegs death, national broadcasting company asking Blom to experiment with Griegs recordings and make a new work; took the MIDI file that Chase provided and produced a music "where Grieg's very free phrasing is fairly intact but all the notes are slightly out of place, it is better heard than explained. In the record this is performed once by a sampler I made for the occasion and on the other side the music is performed by a human, the pianist Ellen Ugelvik [...]. So, here there is also a case of man and machine interpreting the same material, just in two versions rather than the oscillating in a single performance" (communication Christian Blom, January 20, 2017); listening to these records on an "obsolete" player in the Media Archaeological Fundus: a moment of cognitive confusion on which parts are "human" and which are "machine" until became clear that apparently the two records had been placed in reverse cover; for the listener it is vital not to confuse side B with side A, and to play the Al Khowariznmis Orkester not at 33 RPM; that (unintentionally) adds to the compositional idea; the CD version of Bring Me that Horizon, transferred to the experimental setting of Lyriske Stykken: all the difference if the "mechanical", computer-generated version (side B) is played from vinyl which makes is analog signals; from CD, on the other hand, the side A version (human pianist) would be digital signals nevertheless

- Norwegean composer Christian Blom's record using "chance operations and computer algorithms to write the music, then it is performed by a physical mechanical orchestra on the one side. The recording of the mechanical orchestra is then recomposed/transcribed for a sinfonietta (16 instruments) which is presented on the other side of the record. One gets a sort of comparative listening situation where the versions serve as reference for each other, each heavily adapted to its formats and standards" (communication Blom, January 2017)

Fingers, numbers, MIDI notes: "digital music"

- difference between score typewriter (Musikinstrumentenmuseum SIM Berlin) and Various methods of storing sound information for self-playing musical instruments: pinned barrel (Stiftwalze), perforated cardboard

- 1872 Alexandre Amédée develops an electrically driven score writing apparatus

- alternative kind of "phonography" of piano play: Binet / Courtier 1896, article "Recherches graphiques sur la musique", suggesting continuous capturing of dynamics in play = Reinhart

2005: 76

- form and function of the *Rollenschreiber* resembling the inscription device in Morse telegraphy = Ludwig Peetz, Das Welte-Mignon-T100-Aufnahmeverfahren: Aktuelle Forschungsergebnisse zur Dynamikerfassung, in: Dangel (Red.) 2005, 92-105 (99); cp. Embossy Telegraph triggering the Edison phonograph invention

- The typewriter keyboard is media-archaeologically derived from a) piano keyboard, b) telegraphic letter statistics. For character recognition, little differences in tone and time and inter-space make no decisive difference; for piano key attack, addressed to the time-sensitive ear, small temporal change makes all the "musical" difference

- piano not a type-writer (Wolfgang Scherer, "Klavierspiele"); piano keyboard, from which the typewriter dispositive itself has been developed, one the one hand relates to discrete, "digital" notation. But different from alphabetic writing, "touch and tone" dynamics belong to the piano performance as well. Does the pianist become a Turing-machine when coupled into (processing coded information) circuit of score / pinao keyboard?

With/out keyboard: The (non-)Pythagorean electronic synthesizer

- piano key-board as interface to electro-acoustic synthesizer dissimulating the sound-processing medium technology; Don Buchla's modular electronic synthesizer system *without* key-board[727] (the difference to Moog) as input device / interface; transient vs. intransitive

- incorporation: transition between musical intention (in Shannon's diagram: "source") and body-physical implementation / coupling to the instrument; player at that moment of contact as well being played by the instrument

- with the input device of the keyboard, even the "analog synthesizer", media-phenomenologically, a "digital" instrument - even if, strictly speaking, it was only the Musical Instrument Digital Interface (MIDI) standard of 1981 which - embodied in the Yamaha DX7 (since 1983) achieved the break-through to digital synthesizers.

- Tellef Kvifte, Musical Instruments and User Interfaces in Two Centuries, in: Frode Weium / Tim Boon (eds.), Material Culture and Electronic Sound, Washington, D.C. (Smithsonian Institution Scholarly Press) 2013, 203-230; methodological dichotomy between media archaeology and media phenomenology

- discrete input *via* interface vs. pure gospel of analog, "immediate" control; truly "voltage controlled" Analog Computer vs. Digital Computer

- direct circuit control closer to the electronic device, corresponding with a truly media-archaeological aesthetics of techno-logical (pitch control / coding) immediacy and transitivity

- Pinch / Tocco differentiating synthesizer aesthetics of Buchla and Moog respective to the patch cords they used: "Patch cords are the wires that allow the operator to flexibly connect up

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[727] See Trevor Pinch / Frank Trocco, Shaping the Synthesizer, in: The Sound Studies Reader, ed. Jonathan Sterne, New York (Routledge) 2012, 254-264 (257 f.)

the different modules on a synthesizer. <...> Buchla felt that his separation of signal from control voltages made more sense electronically" = Trevor Pinch / Frank Tocco, Analog days. The invention and impact of the Moog synthesizer, Cambridge, Mass. / London (Harvard UP) 2002, 45

- towards a truly medium-specific aesthetics; message of the medium electronic synthesizer (in terms of McLuhan) closer to the real (both electro-physically and physiologically); *not* (yet) "beyond" media-specific aesthetics, as claimed in the introduction of Liv Hausken (ed.), Media Aesthetics (2013)

- in music automata, sound emanating from mechanical combs: a "digital" procedure *avant la lettre*, a mechanized score with punctual, discrete coding like the punched card. Then came the phonograph, enabling analog, wave-form signal recording. Finally return of the digital, in compact disc recording. Pits are here engraved like in the punched card before, read out by laser light, deciphered again as zeros and ones. The bit streams are then being computed into musical information and can be experienced as sound after digital-to-analog conversion via transduction in loud-speakers. But once sonic information has been likewise computed, it has changed its essence completely, even if it still sounds like sound; its inherent sonicity is vibrational matter no more

- keyboard culture (discrete input) vs. ribbon (German *Bandmanual*): the (literally) "digital" vs. the inuitive "analog" hand (finger) input = Pinch / Tocco 2002: 60 ff.; both the Ondes Martenot and the Trautonium applying ribbon control to produce continuous changes in pitch = Pinch / Tocco 2002: 337, note 6

- Museum of the Massachusetts Institute of Technology exhibits a modular analog synthesizer, "patched" by xxx Paradiso: alternative to Graphical User Interface aesthetics in contempary computing; technical infrastructure lying bare, for immediate usage: no "pre-sets", just the actual state: patched sound, singular in its configuration

Transparency of the circuit diagram instead of the metaphorics of user-friendly interfaces (case study Kurenniemi)

- Kurenniemi's electro-acoustic devices demanding engineering skills from the musician operating them; mostly experimental prototypes, "the user interface does not hide the inner design of electrical circuits, and, indeed, the circuits themselves have clearly had a strong influence on the user interface design of these instruments"[728]; techno-archive is *opened for access*

- Kurenniemi's electronic instruments reflecting the technical functionality "at the hardware level" = Ojanen et al. 2007: 92 = the media-archaeological layer indeed, with the input mechanism being mainly the 'plug in' interface

- electronic analog computers as "twins" of electronic synthesizers, even closer to algorithmic

[728] Mikko Ojanen et al., Design Principles and User Interfaces of Erkki Kurenniemi's Electronic Musical Instruments of the 1960's and 1970's, in: Proceedings of the 2007 Conference on New Interfaces for Musical Expression (NIME07), New York, NY; online: http://www.nime.org/2007/proc/nime2007_088.pdf

user interfaces like MaxMSP or Pure Data today

- Kurenniemi's austere resistance to apply conventional control interfaces like a keyboard prefers the pure doctrine of electronic synthesizer access; expresses the discontinuity which takes place in conventional vs. electronic music instruments instead of hiding it in the sense of Marshall McLuhan's (content of a new medium always the previous medium. Kurenniemi "did not choose to use a concentional musical instrument user interface (e. g. a keyboard)" = Ojanen et al. 2007: 92, resisting the temptation to interfacial metaphors

- series of Kurenniemi's "Digital Musical Instruments" from the 1970s, from: Ojanen et al. 2007: http//www.nime.org/2007/proc/nime2007_088.pdf: Dimi-A and diagrammatic Dimi-A touchpard layout = Fig. 3 in Ojanen et al. / Dimo-O (photography) with peripheral in/out interfaces (key-board and video monitor = Fig. 4 in Ojanen et al. / Dimi-S with sensory input device = Fig. 6 in Ojanen et al.

- human hand loses its supremacy in controlling the surrounding machine world in favor of a multi-sensatory display

- *live coding* / With-Time-Programming

- according to Heidegger, objects and properties not inherent in the world, "but arise only in an event of *breaking down* in which they become *present-at-hand*. <...> A breakdown is not a negative situation to be avoided, but a situation of non-obvisousness, in which the recognition that something is missing leads to unconcealing <...> some aspects of the network tools that we are engaged in using <...>. This creates a clear objective for design - to anticipate the forms of breakdowns and provide a space of possibilities for action when they accur." <Winograd / Flores 1986: 36 u. 165>

- Truly media-archaeologically, the interface "instead can become a zone of difference and potential conflict"; irritation reveals the medium (Heidegger's "ready" vs. "present at hand")

- Lev Thermen's design of *Terpsiton*; re-enactment (improvement to knowledge machine) Berlin: Haedicke; difference intuitive (continuous *glissandi*) and discrete (intonation), closer to typewriter / scalar musical instruments: connecting to mathematical theory (Pythagorean numbers)

- patch & tune: "tuning" of the analog computer / synthesizer = parameter modulation, vs. discrete (quasi-numerical) = analytic key-board approach (music instruments / computer interface); "counting" with differences: intuitive tuning and hand-moving instead of "digital" finger counting"

A sonic medium and its epistemic message: the monochord as instrument of knowledge research

- in a prehistoric bone flute, archaeologists seek its cultural "meaning", media-archaeo-

acoustics focuses on wavelengths and reverberations[729]

- Martin Heidegger, Sein und Zeit, xxx, 385: "Die Wiederholung ist die ausdrückliche Überlieferung, das heißt der Rückgang in die Möglichkeiten des dagewesenen Daseins"; listening to the instrumental argument itself which is not subjected to musical composition (not used as a musical instrument) but a knowledge un-coverer (sound-archaeologically); circumstances, even the ways of listening and the psycho-physical tuning of ears, is different; still the monochord is a time-machine in a different sense: share / participate ("communicate") the original discovery of musicolgical knowledge; in technology, the repeatable *is* the original, while in phenomenology the "event" is a singular and instant act which can not be subsumed unter general terms; in Heidegger's late philosophy, the fundamental notions of *being* (Sein) and *time* (Zeit) konverge in the notion of the *event* (Ereignis).[730] In this double sense, the experiment allows a unique experience and at the same time for com/munication across the temporal gap (bridging a temporal distance; the processual moment of the re-enacted experiment sharing the same temporal *field* (a notion which implicitely refers to the episteme of electromagnetic induction. Media-archaeological experimentation (simulation as opposed to historiograpic historicism) gives access to the invariant elements of knowledge in time

- vibrational mechanics becoming intransitive with electro-acoustic wiring as materialized diagram; finally algorithmic programming, more "musical" in terms of composition which is variant in electro-technical implementations (such as different "execution times")

- technical repeatability allows for an almost a-historical functional re-enactment; experience of hight-tech media time is closer to the criteria of experimentation in natural sciences than to the historicist idea of empathetic history. The technological reproduction of a sequence of sound succeeds in exactly the same way as the original, even if it successively uses modern formats. What difference is between a functional technical component of previous generations and its actual embodiment? In most cases, the performance is as good, exactly because techno-logics is basically operative and not performative - *gleichursprüngliches* re-enactment

- Nicola Vicentino's 1555 *L'antica musica ridotta alla moderna prattica* designs an "Archiorgano" which provides for 31 tone grades per Octave, mechanically almost impossible short-cut to contemporary algorithmic realizations of micro-tonality; research project Studio31 at Basel Academy of Music actually (re-)building that diagram; time-delayed engineering = active media archaeology, final (partial) realization of Babbage's Difference Engine No. 2 by Science Museum London (Doron Swade)

Sonic memory's two technological embodiments: physical signal and archival symbol

- in their physical existence, both mechanical and electronic storage devices allowing for time-invariant replay of audio signals; increasingly subject to macro-temporal entropy over time

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[729] See Francesco d'Errico / Graeme Lawson, The Sound Paradox: How to Assess the Acoustic Significance of Archaeological Evidence?, in: Chris Scarre / Graeme Lawson (eds.), Archaeoacustics, Cambridge et al. (McDonald Institute for Archaeological Research) 2006, 41-58

[730] See Martin Heidegger, Beiträge zur Philosophie (Vom Ereignis), [= Gesamtausgabe III. Abt. Unveröffentliche Abhandlungen Vorträge - Gedachtes. Bd. 65.], Frankfurt/M. (Klostermann), 3rd edition 2003

such as the material deteriorisation of Edison cylinders or magnetic tapes. "Analogue" sound recording media like phonographic, gramophonic and magnetophonic records are subject to entropic time themselves; they "degrade over time in quality with every copy and in themselves.

- sonic media artefacts not only preserving the memory of cultural semantics but past *technical* knowledge as well, kind of frozen media knowldege embodied in engineering and waiting to be un-revealed by media-archaeological consciousness

- Technical Committee of IASA in its recommendations from December 2005 insisting that the originally intended signal is just one part of an archival audio record; accidental artefacts like noise and distortion part of it as well - be it because of faults in the recording process itself or as a result of later damage caused in transmission; both kind of signals, the semantic and the "mémoire involontaire", message *and* noise, to be preserved in media-archival conservation ethics

- between mechanical and electro-magnetic audio recording, not just a technical, but as well an epistemological difference. While the phonograph belongs to what Jules-Étienne Marey once called the „graphical method“ (analog registering of signals by curves), the magnetophone is based upon the electro-magnetic field which represents a completely different type of recording, in fact a true „medium“. What used to be invasive writing has been substituted by electronic recording; writing now re-turns as digital encoding in different qualities.

- Video artist Bill Viola, in his essay on what he calls the *sound* of electronic images, pointing out "the current shift from analogue's sequential waves to digital's recombinant codes" in technology.[731] Sampling and quantizing of acoustic signals analytically transforms the time signal into the information of frequencies which is the condition for technical re-synthesis (Fourier transform). Digitalization means a radical transformation in the ontology of the sound record - from the physical signal to a matrix (chart, list) of its numerical values. Media culture turns from phonocentrism to processual mathematics.

- Technical Committee of the International Association of Sound Archives in her standard recommendations from December 2005 pointing out that any such rules of audio preservation need to be revised when changes of the technological conditions take place.[732]

- digital data in need of constant up-dating (in terms of software) and „migration“ (in terms of hardware to embody them). From that derives a change from the ideal of frozen eternity to permanent up-dating: dynamic preservation; material transfer not just the function of a more or less linear time base any more, but a basically atemporal dimension opens, under-tunneling the familiar time arrow of cultural tradition

- Nyquist / Shannon sampling theorem of digital sampling analog signals betrays the naturalist (physical) criterium of indexicality, by proving that (at least for the range of human sensual perception) a continuous signal can be quantized and time-discretely be digitized and still be reconstructed without loss of *information* when this is done with a frequency which (at least) doubles the highest frequency contained within the signal.

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[731] Viola 1990: 47

[732] See http://www.iasa-web.org/IASA TC03/IASA TC03.pdf (accessed June 2011)

- oversampling phonographic records allowing for archiving the noise of the apparatus itself as well

The *a priori* of the sonic time machine: re-encacting electronic music / piano rolls electronically

- Alexander Bell, experimenting with electric voice transmission, occasionally inventing his tuning fork telephone. "You can easily perform this same experiment" today, writes Ed Evenson, author of *The Telephone Patent Conspiracy* of 1876, and addresses his reader in an online "re-presencing" (Sobchack) of the experiment as heuristic "operationality": an arrangement which short-circuits the human ear and the vibrating tuning fork / hand *via* electricity through water as conducting medium.[733]

- due to the physicality of technical media, their past configurations can endure or even re-occur in the present. A technological equivalent to the re-enactment of Pythagoras' supposed experiment with the mechanical monochord string (due to the analogy between mechanical and electric "resonant circuit"; Barkhausen, *Schwingungslehre*) the re-performance of electronic music

- emulation of an analog electro-acoustic synthesizer by digital software a quotation since even digital signal processing and the sampling theoreme remains on the symbolic functional level

- world of difference between functionally simulating or emulating a previous computer game console on a contemporary computer platform; simulation about including the temporal idiosyncracies and material frictions of the "original" computer as well, not simply its computational function (the algorithm), but its real implementation, the physical embodiment of its methematical logics. A particular webpage design of media art functions in different times when simultaneously accessed from machines with different clocking; a given chunk of code may be executed faster or slower as computational processors and operating systems vary (suggestion by Marcus Bastos, September 9, 2016) - a playful target for time-critical Internet Art (Jodi, Vuk Cosic), but a challenge for the concept of preserving the cultural heritage of the computational present by future emulation. *Re-presencing* (Vivian Sobchack) the technological past depends on machine times and program lifecycle phases such as compile time, link time and load time

- sound technically emanating from an ancient Edison phonograph cylinder contains physical traces both from the past recording for time-delayed replay, *and* the present noisyness of the machine - a "temporeal"; its cracks, architecture revealing its entropic destiny[734], kind of *écriture physique* inbetween structural order and entropy

- whereas the circuitry of a Nintendo *Game and Watch* handheld electronic game from 1981 keeps its contemporary sound as implicit information; its electronic circuitry, its ICs and its loudspeaker enabling analytical investigation, recreating the same auditive events that the device would have produced when it was first sold; re-generated techno-logical sound differs from simply transductive replay such as the pick-up of phonographic records; the device itself

[733] http://www.antiquetelephonehistory.com/sciencefork.html; Abruf 23. Juli 2014

[734] Karl-Eugen Kurrer, Zur Geschichtlichkeit von Bauwerken, in: Stahlbau vol. 70 (2001), no. 9, 159

allowing for a co-originary experience

- Collingwood's notorious claim that historians have to "re-enact" the past event partly deriving from his astonishment that a present performance of a musical piece composed at some earlier time can still be understood at all. This requires that the auditor performs it again in imagination.[735] Different from historical imagination in its literal visual sense, "the *sine qua non* of writing the history of past music is to have this past music *re-enacted in the present*"[736]. This practice of re-presencing (well known in its technological equivalent as hardware and software replication and emulation in Retro Computing culture today) escalated in audio recording media such as the phonograph.

- analogy between musical instruments and electronical media essential: both "time-based" in their function. They come into being only as "time objects" (German *Zeitobjekte*, according to Edmund Husserl's phenomenology). Only "re-enactment" of such (media-)archaeological artifacts allows for an operative analysis of such techniques; at the same time, it brings the user/player/researcher in a rather non-historical relation to the past. "Hands-on" such instruments is the ahistorical gesture *par excellence*, different from hand-written historiography: "Anders als die Mediengeschichte geht die Medienarchäologie davon aus, die historischen Geräte zwecks Klangerforschung und Entwicklung neuer kompositorischer Konzepte in Betrieb zu nehmen" = Peter Donhauser, Österreichische Pioniere der "Elektrischen Musik" und die Medienarchäologie, in: Gethmann (Hg.) 2010, 73-96 (92)

- history-defying short circuits, invariant towards change in time or space, presuppose that the physical and electromagnetic laws (and the actual circuitry) known to previous engineers can still be set in operation today. "Mathematically encoded laws of nature, then, occupy the place once held by the place of the music of the spheres [...] of quasi-angelic timelessness, into which those of us equipped with the required computational expertise can momentarily escape [...]."[737]

- techno-logical sense of time everything but *metaphysical*; media-archaeological research is rather rooted within the physicality of technical media. Within the physicality of technical media past setttings can endure or re-occur. Therefore the "re-enactment" of (media-)archaeological artifacts such as electronic music instruments brings the player in a rather non-historical relation to the past. "Hands-on" such instruments is the ahistorical gesture *par excellence*, different from hand-written historiography of culture and science.

- colossal Wurlitzer cinema organ has to be operated frequently "hands-on"; otherwise the electro-magnetic contacts would corrode with time and thus block the musicality of the *organon*; physical entropy it materialized time at work her on the most essential level. Not being reduced to a musical-cultural jewel but looked at as a machine such an instrument behaves just like a steam engine from the age of the early Industrial Revolution on a technical

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[735] See William H. Dray, History as Re-Enactment: R. G. Collingwood's Idea of History, Oxford et al. (Oxford University Press) 1995

[736] Collingwood's 1928 lecture "Outlines of a Philosophy of History", published in: R. G. Collingwood, The Idea of History [*1946], rev. ed. Oxford et al. (Oxford University Press) 1993, 441

[737] Geoffrey Winthrop-Young, Kittler's Siren Recursions, forthcoming in: xxx; actual URL: xxx

museum.

- obsolete computer programs and electronic hardware a challenge for conservation; Chiara Marchini Camia, Digital Art Works. The Challenges of Conservation, Karlsruhe (ZKM) 2012; Simon Emmerson, In What Form Can "Live Electronic Music" Live On?, in: Organised Sound 11, no. 3 (2006), 209–219

- at Lucas Research Group laboratories of Brunel University in England, an Electric Leo Marconi computing machine, filling several cabinets, with both punched card and perforated tape inputs, allowed for acoustic output of data, "ostensibly so that the programmers could get an idea of what was going on." Apparently "it was relatively easy to cause the machine to do various useless things for a long time during which a certain sound would be made. Thus it could, in a way, make music, because the punched cards could be stacked up so that it almost made a scale, or some other recognizable sequence. Once assured that no harm could be done to the machine, I was struck with the idea of shuffling the cards (random sounds) and of ordering them according to ideas other than the sounds they made" = White Heat Cold Logic: British Computer Art 1960 - 1980, edited by Paul Brown, Charlie Gere, Nicholas Lambert, and Catherine Mason, Cambridge, MA (MIT Press); pdf 393