[ON SONICITY]

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SOUND MATTERS

"Post-digital" nostalgia for sound matter? On *Untitled II*

- on lecture-performance by Marianthi Papalexandri-Alexandri, Assistant professor of Music Composition, Cornel University, Music Department, 9th January 2017, Humboldt University, series *Fundus Fundamentalis* no. 4: *Untitled* series centers upon a frictional sound device developed in collaboration with kinetic artist Pe Lang; "stick-and-slip" effect: slowing down the familiar violin tone which is frictive sound from bow-to-string; turns out as saw-tooth signals rich with overtones; part of Apparatus project which acoustically activates and transforms spaces into resonant bodies by challenging architectural and site-specific contexts; Media Archaeological Fundus at spatial intersection of media studies and musicology, with its door as binary relay / switching passage; composer insists on Fundus as site for the co-presence of the technological artefacts; in fact, after ending of performance, a mechanical clock had started ticking: instrumental energy transfer by resonance / signal

- explicit non-electronic, "post-digital" sound production: generating mechanics is transparent; ephemerality of sound in phenomenal hearing is contrasted by the insight into its very material source / presence of matter and artefacts

- discovery of electro-acoustics, mechanically sounding body no longer conditional, de-coupling the sonic event from matter; pick-up of an electric guitarre transduces 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 audio 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)

- "post-digital" art searches for ways to re-inject bodily and other matter back into electronic sound

- co-agency of sound-generating electronics, almost independent of the performer simply triggering / initiating the frictive oscillations; in the cybernetic sense: "controlled" by subtle positive / negative feedback once coupling of human / instrument to "system" happens

- questioning and transforming the role and function of the mechanical instrument as a sound-generator; primary component of an electro-acoustic synthesizer, the “oscillator”, connecting electronic components in a feedback loop; LCR circuit contains capacitor, coil and resistor

Matter sounds: Acoustic earthquake monitoring

- recording for subsequent analysis of otherwise ephemeral vibration; sound has to be inscribed in solid matter; in reverse, wave forms in a solid medium can be functionally sonified without heaving been articulated as sound in the first place; functional sonification a major practice to detect sudden changes in monitoring earthquakes. Here, *matter sounds*: "By time-compressing the output of a seismometer, it is possible to present seismographic data in an auditory display."[1] 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." Speeth accentuates "the ear's ability to use the information contained in the temporal dynamics of the short-time audio spectrum" <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 cards wer 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

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1 Sheridan Dauster Speeth, Seismometer Sounds, in: The Journal of the Acoustical Society of America, vol. 33, number 7 (July, 1961), 909-916 (abstract)

study of transient effects"[2]

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

- difference between French *versus* the German origins of electronic music. On the one side is 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 combinations. On the other hand there is the *Studio für elektronische Musik* established under dirctin 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 serial aesthetics, statistic probabilities, mathematical stochastics ("sound" from the media-archaeological view or better: listening)[3]

- Schaeffer's *Phonogene* (like his *Morphogene* continuous like phonograph. "sons animés" = Duchampean concept of "found obects", Pierre Schaeffer, Traité des objets musicaux, differnzt form "objet sonore". The (normally hidden) kinetics of sound production in the Paris studio, like the Nietzschean "hammer" = tuning fork. not at all complegelty "acousmatique". But no "lelectronic" music in the strict sense; there is no kinetic element in full electronics (instead of simply "electrics"): term derives from the triode, undoing all mechanical hindrance. no kinetic but cybernetic coupling as electric circuitry, elemtro-magnetic inducting happens withpout bodily kinetic intervention which is still cultural technology. machine music vs. elecronic music (Meyer-Eppler). Schaeffer: performative electro-mechanism; Cologne studio: operatie by machines. still "hands on instrument" in cologne, but in the cybernetic sense of directing (Steuerung), not: direct sound proiduction 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

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2 Speeth, 909, note 5

3 See Friedrich Knilli, Das Hörspiel, Stuttgart (Kohlhammer) 1961, 30 f.

- in micro-physical *close listening* as "understanding" of sound, the materiality of the recording medium itself becomes poetical; instead of musicological hermeneutics, the media-archaeological ear is required

- Bill Viola on the implicit *sound* of electronic images, "the current shift from analogue's sequential waves to digital's recombinant codes" in technology.[4] 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 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 are sonificators themselves

- "sound" from a CD player nothing but a sonification of a serial array of binary data, that is: square-shaped signals. This 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

- occidental musical theory dominated Pythagorean epistemology: Music is not the sonic event in itself but a phenomenon of integer mathematics, thus: symbolic regime. But sound is mathematics *in operativity*, that is: implemented into vibrating matter, sonically emanating real numbers

- 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[5]; digital data need constant up-dating and „migration“ (in terms of emulating hardware to run them). From that derives a conceptual shift from the frozen archive to permanent re-implementation

Re-entry music as symbolic form: computing

- *musical* memory symbolically notated in scores, while *sonic* memory preserved in signal-based phonograph recordings, endowed with "temporal indexicality"

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4 Viola 1990: 47

5 See http://www.iasa-web.org/IASA TC03/IASA TC03.pdf (accessed June 2011)

- different from the age of handwritten and printed textuality, electronically stored data 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"[6]

- in computational media, the alliance between computing (algorithm) and *mousiké* (rhythms) implicitely returns; sonicity "matters" not as actually acoustic, but processual event

"Computing by sound"

- immediacy of sound and "musical" con/structuring of time; Leibniz' model of music 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, but usually are not embedded in a media-theoretical model of time; the nearer we come to future computational speed, the closer we are "back" to the foundations of things in ancient Greek musical theory. Aristotle used the concept of number to determine the entity of time, but left his general critique of the Pythagorean number cosmos to his pupil Aristoxenos of Taras; while carefully tracing possible harmonic transitions and melodic modulations between scales or 'systemata', Aristoxenos came up with an nonlinear combinatorics of musical sound whose dynamics afforded to introduce an essentially time-bound model of reasoning: a throughout logical system based on harmonic relations and movement where a recursive, ever ongoing account of possible future pathways through the harmonic web of scales affects their present intonation; the actually selected melodic path is rendered a reality by the singing voice and its adaptive pitch intonation; such melodic processes can be regarded as computations by sound; a proper musico-logical understanding of Greek melodies entails a recursive model of time, while a suitable computer modelling of their intonation affords parallel computations incompatible with the classical model of turing machines; implement Aristoxenos' unforetold 'computing by sound' and thus demonstrate the then virtual logic of melodies by today's media and means of an electronically augmented ancient Greek barbiton lyre = argument PhD thesis Martin Carlé

Abuses of "sound" for computer graphics

- Stefan Höltgen, 23 January 2015, Signal Laboratory, on 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

- hybrid inbetween: "Digital Vector Generator" (DVG) as internal chip between digital computer and vector screen bildschirm (addressed by Opcodes)

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6 Jeff Rothenberg, Ensuring the Longevity of Digital Documents, in: Scientific American, Vol. 272, No. 1 (January 1995), 42-47 (42)

- term "Rasterbildschirm" means *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"

- with the "resonant circuit", radio suddenly becomes the "sonification" of an *implicit* "syntony" (David Lodge); Aitken 1976

- listening to the noise of the machine as much as the message; to listen media-archaeologically is to pay attention to the electronic message of the acoustic apparatus, not primarily to its musical content as cultural meaning; media-archaeological ear listens to radio in an extreme way: to the noise of the transmitting system itself; thus the archaeological investigation becomes closer to engineers' signal analysis of physical media and consequently moves beyond the semiotic hermeneutic interpretation of media artefacts

- uncover (*aletheia*) the hidden agenda of technomathematical artefacts, or artefactuality, being concerned with media not only on their structural but on their *operative* level. Heidegger himself 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)

- 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 might be 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 cares 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; cp. 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 there is 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)

- concept of archaeoacoustics "might seem to be counter-intuitive. We associate sound with transience, while archaeological sties, by definition, embody ancient time"[7]

- no wave-based model of acoustics in antiquity = Devereux ibid., inhibited by symbolical regime of "musical" order

- sonic media "ecology" = controlled environmental sound; Vitruvius on theatre architecture and resonance

- archaeoacoustics by modern performance of music at ancient sites; investigative research "using monitoring with *electronic* instrumentation" = Devereux ibid., such as sound generation (wide frequency "pink noise"), and studying acoustic resonance inside acoustic spaces; sirenic research

- resonance frequency detected 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[8]. Suddenly the past can be made to "speak"[9]

Tuning into the past

- possible to "tune" into the past in a kind of Heideggerean "Stimmung", as a temporal short-cut. "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'."[10] 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

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7 Paul Devereux, Sound & Ancient Sacred Places, in: UN TUNE. CTM - Festival for Adventurous Music & Art, 16th Edition, Berlin 2015

8 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

9 See M. S. Bruchez, Artifacts that speak for themselves. Sound underfoot in Mesoamerica, in: Journal of Anthropological Archaeologiy 26 (1), 2007, 47-67

10 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)

elecronics was thus merely an act of algebraic translation."[11]

- consciously artifactual 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, it can rather be "understood" epistemologically, as an index of *LoFi* sound as media criticism and as a technically self-reflective potential of disturbance and noise. From that derive present speculations about sonic materialism

- for textual philology, a text never exits "outside of the physical support that offers it for reading (or hearing)"[12]

- inherent law of technical media themselves to dissimulate, to become unperceivable, im-material in their materiality, to become sonically anesthetic

- Lauri Siisiäinen, Foucault and the Politics of Hearing, New York (Routledge) 2013, chap. "Message or Noise", 31 ff.

Message or noise? Acoustic archaeology

- among the ontological premises following from implicit sonicity: address “noise” as an emblematic part of media. "'Media studies going bad' refers to the fact that also scholarly analysis has to address the anomalies and noise of media culture"; noise in this sense refers not only to the various shapes of acoustic noise that are of relevance for sonic media archaeology, but in the sense of digital and network noise – the possibilities of intrusion, interruption and scrambling of messages of communication" from the 19th century telegraph onwards = Introduction to planned book *Travelling Cartographies: Media Archaeology and Cultural Analysis* by Jussi Parikka (draft July 2009); theme of noise and accidents important for a wider consideration of ontology of

11 Miyazaki 2015: 65

12 Roger Chartier / Guglielmo Cavallo 1999: 5, as quoted in Papenburg, op. cit.

technical media

- preliminary 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"[13], emphasis in favor of *close listening*: to the technological artefact itself; Museum of Endangered Sounds takes care of the sound of "dead media"[14], 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 «mémoire involontaire», message *and* noise, need to be preserved in media-archival conservation ethics.

- Edison wax cylinders from the beginning of the 20th century may very well contain background recordings of environments that were never entended for memory but now "recall (if an earlier event can recall a later one) the Soundscape Project in Vancouver [...]" = announcement of the course *Time waves goodbye* guided by Anthony Moore and Peter Kiefer at the Academy of Media Arts (Kunsthochschule für Medien), Cologne, Summer term 2000. What 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, (or three if you take into account the now-time you are listening in, which is always changing)» (Moore / Kiefer). It is the media-archaeological intention to dig into collections of early recording machines in such a non-historical way (anti-hermeneutically). Out of this archaeological site develops a different "hearing" of modern history, a notion of the sound of the past based on waves, simultaneous time and shifting soundscapes[15]

- 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

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13 See Bijsterveld 2008, chap. 1

14 See the Website „Museum of Endangered Sounds“, *online* http://savethesounds.info

15 See Tony Schwartz, The Responsive Chord, New York 1974

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.

- since Pre-Socratic Greek philosophy, music not just a practice of acoustic pleasure and entertainment, but served as a model of knowledge - *mousiké epistéme*. More specifically, 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.[16] But instead of crossing that border, as the son of the theoretician of music Vincenzo Galilei he 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” memory / storage / transmission, since this 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 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 has been set

- Humanities (*Geisteswissenschaften*, as defined by Wilhelm Dilthey) have for the longest time not been concerned with the phyically real - due to the limits of hermeneutics as text-oriented method, to the privigeging 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.[17]

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16 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)

17 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

- phonography did not just provide 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"[18], *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. The 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 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 belongs 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

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Geisteswissenschaften. Zweite Fassung, in: same author, Gesammelte Schriften VII, 311

18 DeMarinis 2002/2010: 247-252 (247)

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.

- When sound, let to its own surroundings, articulates *it*-self, it 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 Zweiten 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"[19] 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[20]

- 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“ character) by its mass multiplicity. Temporal tradition is thus replaced by a rather topological dissemination.[21]

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“.

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19 Claude E. Shannon, The Mathematical Theory of Communication [1948], in: ders. / Warren Weaver 1963: 29-125 (65)

20 Rudolf Taschner, Der Zahlen gigantische Schatten. Mathematik im Zeichen der Zeit, Wiesbaden (Vieweg) 3. Aufl. 2005, note 77

21 Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit [originally published in its French translation 1936], Frankfurt/M. (Suhrkamp) 1963, 13

Whereas an 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 by coding (as Norbert Wiener in his *Cybernetics* insists).

In media-active archaeology, the technological apparatus itself turns out to be the archaeologist 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“[22], in fact is something media-epistemologically different, a picking-up of a completely new kind: digital sampling

"Spectralism" as compositional technique in contemporary music

- "*Defined in technical language <italics* W. E.>, spectral music is an acoustic musical practice where compositional decisions are often informed by sonographic representations and mathematical analysis of sound spectra, or by mathematically generated spectra. The spectral approach focuses on manipulating the spectral features, interconnecting them, and transforming them. In this formulation, computer-based sound analysis and representations of audio signals are treated as being analogous to a timbral representation of sound. [...] originated in France in the early 1970s, and techniques were developed, and later refined, primarily at IRCAM, Paris [...]; as Joshua Fineberg puts it, a recognition that "music is ultimately sound evolving in time".[1] Julian Anderson indicates that a number of major composers associated with spectralism consider the term inappropriate, misleading, and reductive.[2] The Istanbul Spectral Music Conference of 2003 suggested a redefinition of the term "spectral music" to encompass any music that foregrounds timbre as an important element of structure or language.[3] The term "spectral music" was coined by Hugues Dufourt in an article written in 1979 and first published two years later [...].[23]

- term initially associated with composers of the French Ensemble l'Itinéraire [...] and the German Feedback group, principally Johannes Fritsch, [...] and Clarence Barlow. [...] Proto-spectral composers include Claude Debussy, Edgard Varèse, Giacinto Scelsi, Olivier Messiaen, György Ligeti, Iannis Xenakis, and Karlheinz Stockhausen. Theoretical predecessors [...] Henry Cowell, and Paul Hindemith. [...] Formal concepts important in spectral music include process, though "significantly different from those of minimalist music" in that all

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

23 See Hugues Dufourt, Musique spectrale: pour une pratique des formes de l'énergie, in: Bicéphale no.3 (1981), 85–89

musical parameters may be affected. These processes most often achieve a smooth transition through interpolation. [...] Sound work is not restricted to harmonic spectra but includes transitory aspects of timbre and non-harmonic musical components (e.g., rhythm, tempo, dynamics). [...] sound is treated phenomenologically as a dynamic presence to be encountered in listening (rather than as an object of scientific study)" = https://en.wikipedia.org/wiki/Spectral_music; accessed June 16, 2016; "sonophenomenological" (Kroier) listening vs. "acoustemological" (xxx) *understanding* of sound as object / subject of epistemic investigation

A media-archaeological approach to sound

- term "sonic" well known to understanding in English, while in German "das Sonische" sounds like a neo-logism and it meant to make a difference to the all-embracing term "Klang" (sound), rather emphasizing the human-machine coupling of sonic media culture

- 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"[24]

- temporality of technical media and their affect on human temporal perception; "sonopoetics" *resonates* 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* (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

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24Constantin Engelmann, Auditory Projections, in: Flusser STUDIES 17 (May 2014), *online*

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; how did Beethoven 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)

- part of *The Dark Age* festival at Amsterdam, 21st to 24th February, 2013 = Sonic Acts XV (Festival for Explorations in Art, Music & Science): "from burial rhythms and encrypted frequencies to droning echoes and colliding dub"

- deMarinis, on the acoustic tempor(e)ality of a re-sounding ancient Roman bell

The "resonant circuit"

- resonant circuit, otherwise called "tuned" circuit = electric circuit consisting of an inductor L, and a capacitor C 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" = http://en.wikipedia.org/wiki/LC_circuit (accessed 23rd January, 2015

- resonant circuits used either as sender (for generating signals at a particular frequency), or as receiver (for picking out a signal at a particular frequency from a band of carrier signals), particularly in radio technology. Such circuits function as oscillators, filters, tuners or frequency mixers

- evidence that a capacitor and inductor could produce electrical oscillations discovered in 1826 by Felix Savary. "[W]hen a Leyden jar was discharged through a wire wound around an iron needle, sometimes the needle was left magnetized in one direction and sometimes in the opposite direction. He correctly deduced that this was caused by a damped oscillating discharge current in the wire, which reversed the magnetization of the needle back and forth until it was too small to have an effect, leaving the needle magnetized in a random direction."

Joseph Henry repeated Savary's experiment in 1842 "and came to the same conclusion, apparently independently" - an instanciation of techno-logical equiprimordiality.

Mathematical evidence: Similar to James Clerk Maxwell in response to Michael Faraday's experimental detection of electro-magnetic induction, William Thomson (Lord Kelvin) in 1853 showed *mathematically* that the discharge of a

Leyden jar through an inductance should be oscillatory, and derived its resonant frequency in an algebraic formula.

Sonic evidence: Oliver Lodge, by discharging a large battery of Leyden jars through a long wire, "created a tuned circuit with its resonant frequency in the audio range, which produced a musical tone from the spark when it was discharged".

Visual evidence: In 1857, Berend Wilhelm Feddersen photographed the spark produced by a resonant Leyden jar circuit in a rotating mirror, providing visible evidence of the oscillations.

In 1868, James Clerk Maxwell calculated the effect of applying an alternating current to a circuit with inductance and capacitance, showing that the response is maximum at the resonant frequency.

The first example of an electrical resonance curve was published in 1887 by Heinrich Hertz in his paper on the discovery of radio waves, showing the length of spark obtainable from his spark-gap LC resonator detectors as a function of frequency.

In his "syntonic jars" experiment around 1889, David Lodge placed two resonant circuits next to each other, each 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 sparks and thus oscillating currents, 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."

Application of LC circuits in the 1890s in spark-gap radio transmitters to allow the receiver and transmitter to be tuned to the same frequency; first practical systems installed in 1900 by Guglielmo Marconi

INTELLECTUALIZING THE VIBRATIONAL EVENT: TECHNO-MATHEMATICAL ANALYSIS OF "HEAT"

Water waves, flimmering air: Order by fluctuation

- conference *Thermal Objects—Theorizing Temperatures and the Social*, 14-15 June 2017, University of Hamburg, Institute for Sociology

- 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). But more important, this 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[25], 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?"[26]

- noise = shape without *gestalt* usually perceived as a symptom of the "sublime" (Edmund Bruke) or the "real" (Jacques Lacan). Thermic "disorder" like weather clouds might turn out highly informational when observed on the micro-temporal level like the Brownean particle motion.

- scene where mathematics and physics actually meet is technical media (media theatre); it happens musically. It is in this way that the phenomenon of Brownian motion has been a focus of Norbert Wiener's mathematics[27]; any scientific recording of such a motion looks like an avant-garde dance performance.

By microscopic close viewing, "it became obvious that small particles sustained in a liquid or gas were subject to a random motion whose future was largely unpredictable from its past."[28] The course of particles in terms of the Brownean molecular movement - depending on temperature - results (in the mathematical sense) in a Gaussean distribution and is approximable in *harmonic analysis*[29] - which links it to Fouriers primary *Analysis of Heat*.

- difference between stochastic noise and well-composed music becomes evident in time reversal: Even if played from tape in reverse, noise sounds equal; Boltzmann's entropy defines the arrow of time.

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25 As quoted in Siegert 2003: 182

26 Norbert Wiener, Mathematik - mein Leben, Düsseldorf / Wien (Econ) 1962, 36

27 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, 68. See Wiener's *Cybernetics* (1948)

28 Wiener 1942: 32, referring to: J. Perrin, Les atomes, 4th ed. Paris 1931

29 Norbert Wiener, Generalized Harmonic Analysis, in: Acta Mathematica, Bd. 55 (1930)

- "temperature" in the epistemological sense different from what human senses and cognition physiologically or phenomenologically perceive

- when the conventional reduction of human physiology to (conventionally) five senses is supplemented by the sense of temperature (thermosensitivity), this corresponds with another (hypothetical) human time-sense

- ergodic ensembles challenge 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.[30]

Informational aesthetics: Entropy in (cloud) painting

Instead of symbolic order by classification, informational aesthetics (Abraham Moles, Iannis Xenakis) allows for ("temperature") 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)

- Heinz von Foerster on long-time development of trends in composition of music: "They are most clearly understood in information-theoretical terms, namely, as a gradual reduction in the redundancy in works of music or, expressed differently, as a continuous increase in the complexity of sound and composition, hence an increase in the amount of auditory information transmitted during a given interval of time. Redundancy reduction has been achieved over the last two millennia by a steady abolishment of constraints on three levels: specificity of waveforms (sounds), selection of frequencies (scales), and rules of synchronism and succession (composition)" = Heinz von Foerster: „Sounds and Music“, 3-10 (9)

- different from anthropocentric concept of culture, Max Bense in his claim for an "exact aesthetics" switched to what a neologism might call *entropology*. Bense identifed the *aesthetic state* as the "energy" of an artistic object, resulting from the mathematically contrary components order and complexity as previously defined by Birkhoff.[31] According to Birkhoff, the "aesthetic measure" (M) equals the ratio of order (O) / complexity (C), oscillating around the borderline between O and C.[32] 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

30 Wiener 1942: 33

31 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

communication" (1948). Therefore "entropy" as a measure in works of art is a category born from information engineering. Rudolf Arnheim in his booklet *Entropy and Art. An Essay on Disorder and Order* once demonstrated what an entropic measure of a piece of art history <Poussin ?> looks like: successive "entropization" of a historical painting[33]

In lecture "The Storm-Cloud of the Nineteenth Century" in 1884, instead of any symbolic order of things, art aesthetician John Ruskin finds in the weather a thermodynamic phenomenon which brings forces into play that radically alter ordinary mechanistic representation, "a form of order understood as process rather than state"[34]; entropy is no threat to order any more, but "an organizing principle of disorder that only made sense when observed from on high"[35].

- William Turner's painterly clouds not simply an aesthetic idiosyncracy but the symptom of a specific 19th century epistemology which in other fields manifestated itself as statistical mechanics (thermodynamics). Turner's painting *Rain, Steam, Speed - The Great Western Railway* from 1844 - which coincidantally is the year of the publication of Talbot's *Pencil of Nature* - expresses physical entropy. His artistic message is color painting itself, not the referential illusion, a "flat" indexicality

Arnheim criticised the transfer of notions of information theory into the field of aesthetics: the overall concept of entropy as temporal vector ignores the art historically derived structure of form and suggests that we must (re-)turn our gaze to the "preserved islands of order everywhere"[36] - which chaos theory (Iliya Prigogine) would call *strange attractors*. As extreme examples "of what he saw as entropy gone mad", Arnheim referred to minimalism, experimental music and avant-garde film (Ballard).

- 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. But then, this intellectual reduction of entropy is accompanied by "thermal" noise affecting the signal

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32 G. D. Birkhoff, A Mathematical Approach to Aesthetics, in: Scientia,September 1931, 133-146

33 From: Entropie und Kunst: Ein Versuch über Unordnung und Ordnung, Köln 1979

34 Thomas Richards, The Imperial Archive. Knowledge and the Fantasy of Empire, London / New York (Verso) 1993, 86 f.

35 Richards 1993: 87

36 Rudolf Arnheim, Entropy and Art. An Essay on Disorder and Order, Berkeley / Los Angeles / London (Univ. of California Pr.) 1971, as quoted in: Susan Ballard, Entropy and Digital Installation, in: Fibreculture Journal 7 (2005); *online* http://journal.fibreculture.org/issue7/issue7_ballard.html (accessed November 2007)

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."[37] 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 is subject to xerographical miniaturization which then in return is being magnified again, it is subject to gradual entropization:

Fig.: "Umzeichnung des Gemäldes 'Der Bildersaal' von Frans Francken II. Ausschnitte aus dem Prozeß einer fünffachen Verkleinerung und anschließender fünffacher Vergrößerung. Konzept: Ulriche Giersch."[38]

- 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"[39]

- 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"[40]

- website for conference www.suchbilder.de still active; its flash animation makes pixels progressively affiliate themselves according to color similarity - a

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37 Quoted after James Gleick, The Information: A History, a Theory, a Flood, chap. 9 "Entropy and its Demons"

38 From: Giersch 1983: 59 f

39 Giersch 1983: 67

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 identyfing individual "styles" in art history

Fourier('s) implicitely "sonic" analysis of heat conduction and its cold calculation

- an implicit sonicity in all Fourier Transformation. Even though Fourier's original publication (1822) on the analysis of heat conduction mentions the possibility to apply this mathematical method to other vibrational and oscillatory events only marginally, especially in electro-acoustic media, Fourier Analysis and Fourier Transformations (Spectrography) has become a dominant algorithmic tool for the processing (and re-production) of audio signals.

Fourier Analysis allows to decompose complex (but periodic) functions like what is perceived as sound into the sum of simple (sine and cosine) waves. According to Fourier, any sound can be decomposed 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 as kymatically and mathematically)

- epistemological de/freezing of the sinusoidal wave / tide / "Zeit". Geo-archival temporality is slow motion; almost immobile memory; "time-critical" in its long-time sense: not perceivable by human / "historic" time sense; Braudel, *La Mediterrannée*; "deep time" of media technologies (Zielinski, Parikka)

- main principle in all oscillators is "a tension between *opposing forces* combined with a regenerative or *positive feedback*"[41]

- correlation between the sense of temperature ("thermoception") and the (substitute) human "sense of time" (the ear) / *temperare*

- by Fast Fourier Transformation, any kind of (digitized) sound broken down into discrete time slices, shunks of sound

- "Ces considérations offrent un example singulier des rapports qui existent entre la science abstraite des nombres et les causes naturelles."[42] Fourier derives a general conclusion: "Plusiers questions de mécanique présentent des résultats analogues, tels que l'isochronisme des oscillations, la rèsonnance

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40 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

41 György Buzsáki, Rhythms of the Brain, New York (Oxford UP) 2006, 142

42 Jean-Babtiste Joseph Fourier, Théorie Analytique de la Chaleur, Paris (Firmin Didot) 1822, 15

multiple des corps sonores."[43]

- Nyquist/Shannon sampling theoreme 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

Fourier's mathematical insight into dynamical processes (which had been pre-conditioned by Leibniz' infinitesimal calculus) is implicitely sonic. Vibrating electrons, atoms and molecules are indeed the cause for energy conduction within and between adjacent bodies. Very appropriately, the quanta of thermic wave energy within crystals are called *phonons* = entry "Thermal conduction" in the online encyclopedia Wikipedia, accessed September 27, 2013

General signal analysis and (re-)synthesis applied to sonic articulations

- in his publication of 1822, Fourier insists that his mathematical analysis is mighty enough to describe not only slowly varying processes like temperature but extremely volatile phenomena - such as the most volatile cultural articulation which is sound, as expressed by the saxophone player Eric Dolphy: "Once it's in the air it's gone, you can never recapture it again."[44]

- subsequent Fourier Transform by no means sound-specific but forcefully applies to all technological signal processing systems of contemporary media culture. Still its specific affinity to sound processing is not accidental but results from the radical temporal unfolding of the physical sound signal itself

- sine wave comes closest to the elementary tone; together with its overtones it is the main target of Fourier Analysis of sound. Hermann von Helmholtz questioned if Fourier's analysis might not be a "mathematical fiction"[45] - "[...] bloß eine mathematische Fiktion, welche zur Erleichtung der Rechnung erlaubt sein mag, aber nicht notwendig irgend einen entsprechenden reellen Sinn zu haben braucht?" - but the human ear performs a mathematical analysis of complex sound into its frequency components itself

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43 Fourier 1822: 15

44 As quoted by Diedrich Diederichsen, T.I.M.E. The Inner Mind's Eye, in: Bieber et al. (eds.), Die Zeit im Wandel der Zeit, 2002, 432-446 (432 f.)

45 Hermann von Helmholtz, Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik, Braunschweig (Vieweg) [*1863]; 6th edition 1913, 58

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.[46]

- after a visit to the "Mapparium" in The Mary Baker Eddy Library in Boson, Massachusetts; http://en.wikipedia.org/wiki/Mapparium; accessed March 30, 2014: "The hard spherical surface of the globe reflects sound and produces striking acoustical effects. It forms a remarkable whispering gallery so that visitors standing at corresponding locations near opposite ends of the bridge can speak to each other and be heard as if they were standing next to each other." Within such spectacular spheres which were meant to shelter the actual radar antenna, nothing could 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. The presence of sound in such spheres is sublime in the sense of Edmund Burke, since one is aware of them but can not perceive them with human senses. Such phenomena of "implicit sound" shall be classified unter the umbrella term *sonicity*.

- "das Sonische" (sonicity) = implicit sound, sound as an epistemic artefact

- in contemporary radio wave transmission, the signals are being coded in binary impulses. Pulse Code Modulation (whose "philosophy" was aptly described by Claude Shannon[47]) 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 does not "listen" 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

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46 http://fantomton.de/experimente/radarstation-2-call-for-tracks/

47 Claude Shannon, Philosophy of PCM, in: xxx

"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 has been replaced by what in English is appropriately termed "eavesdropping", with the acoustic association of water drops falling from the roof rightly indicating the discrete ("digital") granularity of the "sonic" event.[48]

- "mathematical sonicity" is 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[49], 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 undertook a 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*

- electro-magnetic emissionen from computer monitors as sonification

- US-American secret service project TEMPEST = Electronics Material Protected form Emanating Sourious Transmission

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

48 See Wim van Eck, Electromagnetic Radiation from Video Display Units. An Eavesdropping Risk?, Elsevier Science Publishing B.V. North-Holland 1985; *online* http://cryptome.org/emr.odt (accessed September 2013); 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 (accessed September 2013)

49 See Thomas Hermann / Andy Hunt / John G. Neuhoff (eds), The sonification handbook, Berlin (Logos) 2011

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."[50] 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.

- In architecture, this corresponds with reverberative time (the audio signal delay known as "echo"). In the case of ancient and medieval churches, "there is no mention of *intentionally* creating reverberation for its theological relevance"[51]; long reverberation as 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.

- slow run time of acoustic waves even led to the reversal of the cause-effect relation of combat noise in the age of 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. No longer is a danger previously being announced.

- in *Berliner Kindheit*, Walter Benjamin reflects on memory as an analogue of hearing: “The déjà vu effect has often been described. But I wonder whether the term is actually well chosen, and whether the metaphor appropriate to the process would not be far better taken from the realm of acoustics. One ought to speak of events that reach us like an echo awakened by a call, a sound that seems to have been heard somewhere in the darkness of a past life. Accordingly [...] the shock with which moments enter consciousness as if already lived usually strikes us in the form of a sound" = quoted from Guiding Issues and Format of the Sawyer seminar "Sound Studies" at Harvard University

- recording technologies counter-act against the evanescent nature of sonic object by extending / suspending the channel of transmission; made it possible "for the first time" = disruption the ancient Greek "harmonic" musicology, to store, repeat, and manipulate sounds rather than symbolic notation (score or words); even noise as irregular vibrational matter became a signal that could be replicated ("sound culture"), time-manipulated and analyzed (media archaeology)

Psycho-Acoustic Laboratory / Underwater Sound Laboratory, Harvard University

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50 Doug Cooper, Dead Time Is The "How Much Delay" Variable; *online* unter: http://www.controlguru.com/wp/p51.html

51 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)

- twin laboratories installed at Harvard University during WWII: Psycho-Acoustic Lab. / Electro-Acoustic Lab. Are they still existing? At least their "memory" is being recorded in the Harvard University Archives

- Harvard Underwater Sound Laboratory (HUSL) operated by Harvard University during World War II, under contract with the National Defense Research Committee/Office of Scientific Research and Development; purpose to improve available equipment for detection of under water sound, and to design new equipment. The contracts continued through January 31, 1946. Frederick V. Hunt director. Records relate to government contract research in sonar and underwater acoustics at Harvard Underwater Sound Laboratory during World War II. Includes administrative records of Director F. V. Hunt and Associate Director C. P. Boner; correspondence with various companies concerning placement of laboratory personnel after project completion; photographs of experiments and apparatus, and blueprints; staff memoranda; personnel records; staff roster, 1946; and project report, 1945. Files of Director, F.V. Hunt, contain correspondence, memoranda, personnel lists, contracts, minutes and related documents of the Administrative Council, office logs, clippings and manuscript history of laboratory, and items relating to dismantling of the laboratory after termination of its contract. Also included are log books of experimental vessels, reports distributed outside the laboratory including the Office of Scientific Research and Development relating to research progress, apparatus, and related matters.

- Charles H. Sherman / John L. Butler, Transducers and Arrays for Underwater Sound, New York (Springer) 2007; corrected 3rd. ed. 2013

- W.O. Pennell, M.H. Hebb, H.A. Brooks et al., “Directivity Patterns of Sound Sources,” NDRC C4 – sr287-089, Harvard Underwater Sound laboratory, April 29, 1942; Reference in Chapter 5 of NDRC, Div 6, Vol. 13, 1946
[5a] W.S. Burdic, Underwater Acoustic System Analysis, 2nd ed., Prentice Hall, New Jersey, 1991

- The Lab Echo, vol, no. 1. Feb. 3, 1944 - vol. 1, no. 10, Jan. 31. 1945

- V. c. Anderson, Recording-Reproducing System Using a Dielectric Storage Medium, in: J. Acoust Soc. Am. 27, 1004, (A) (September 1955)

- J. J. Faran, Jr., and R. Hills, Jr., "Correlators for Signal Reception", ARL Tech. Memo. No. 27 (September 1952)

- F. V. Hunt, Stylus-Groove Relations in the Phonograph Playback Process, in: Acoustica 4, 33-35 (1954)

- F. V. Hunt, Electroacoustics, Cambridge, Mass. / New York (Harvard Univ. Pr. / John Wiley), 1954

- F. V. Hunt, Acoustic vs Acoustical, in: J. Acoust. Soc. Am. 27, 975-976 (L) (September 1955)

- P. W. Smith, Jr., Precise Measurement of the Velocity of Sound, in: J. Acoust. Scc. Am. 24, 455 (A) (July 1952)

- *Electro-Acoustic Laboratory (1941-46)*: known during WWII as "Research on Sound Control", a project with which the Psycho-Acoustic Laboratory was associated

Records, Pre-Recorded and Recorded Sound: Audiovisual Archives in Transition

- annual conference *A Century of Sound Archiving* of the International Association of Sound and Audiovisual Archives (IASA) in Vienna, 18-23 September, 1999

- contrasting with cultural phantasms of memorizing sound in a pre-technical age, with invasion of audiovisual records in traditional archives a radical discontinuity arose, irritating the symbolic order of libaries and museums in the twentieth century; options of retrieval under new media conditions - transcending the notion of the archive itself

- media archaeology of sound, the "sound" of archival memory, and the "sonic"

SONIC TIME(MACHINE)S

Explicit sound and implicit sonicity as temporal knowledge

- explicit tempor(e)alities of sound in the techno-cultural context and its implicit existence as dynamic object of knowledge

- genealogy of term *sonus* ranges from the concrete physical materiality of sound up to its epistemological definition[52] for which the retro-neologism *sonitas* might be allowed. The concept of sonicity questions the supremacy of visuality in Occidental aesthetics and knowledge. The impact of sound and aural operations, especially in its non-musical variants, has long been undertheorticized; major feature of the relationship between visibility and audibility is its different temporalities

- inquiring into *sonicity* does not equal Sound Studies. Sound in its generalized sense as enunciation of timing refers to continuous ("analog") vibrational and discrete ("digital") frequential dynamics of all kinds, ranging from the most precise (electro-)physical micro-mo(ve)ment over the human affect of temporal perception up to culturally emphatic modulations; split existence of sound: its explicit tempor(e)alities in the techno-cultural context and its implicit dynamics as epistemic object

Techno-sonic time-generating mechanisms and the charming power of sonic eventality to seduce the human sense of times deserves a study of its own. The

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52 See Frank Hentschel, entry "Sonus", *online* www.sim.spk-berlin.de/static/hmt/HMT_SIM_Sonus.pdf (accessed July 2013)

arguments unfolded here result from a long-time research focus on the affinity and 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, where the time signal and its technical processing converge

- discovery of sound not as acoustic but as epistemic object: implicit sound ("sonicity"). On the one hand, soundis thereby not discussed in musicological terms (as it used to be in academic tradition), but related to media culture. The basic assumption is that it is the temporality of sound which couples it tightly to the essence of media operativity; thereby the study is part of a growing field of research into the interrelation between time and technology. For the field of Media Studies which is still dominated by its affiliation to philological or visual studies, this monography points at the special alliance between media temporality and sonic knowledge which - after the "sonic turn" (epitomized by terms like "sonification" and "auditory display") is growing fast. The book introduces media archaeology as one of the most innovative methods in Cultural and Media Studies today; at the same time it addressed two of the most deeply discussed terms in occidental history of knowledge: time and music.

- different from current Sound Studies, "sonicity" as a neologism proposed for the study of implicit sound-like events in physics and technological media; media-archaeological re-interpretation of the presence-generating impact and the uncanniness of human and technological voices in relation to symbolic operation like the phonetic alphabet and digital sampling

- sonicity not reduced to the micro-temporal physical or techological event but leads to a questioning of the dominant cultural notion of historical time in favour of a more dynamic, resonant, multi-layered "sonic" temporality

- analysis of *sonicity* provides insights into the field of tempor(e)alities in cultural aesthetics and cultural engineering; sonic eventality not only time-based, but in a more radical reading it leads humans to experience time at all

- sound and music let experience 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 and music itself from its ephemeral temporality, signal recording media for the first time in cultural history mastered the time axis towards arbitrary manipulation

- sound cultures recently developed into a privileged topic of research; sound is understood less in its manifest acoustic phenomena but in its epistemological dimension, that is: as a dynamic expression which provides insight into temporal forms and shapes of time

- 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; 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

- *das Sonische*, a neo-logism in German language (different from *Klang* which is acoustic "sound") in this context refers to the inaudible vibrational ("analogue") and rhythmic ("digital") field (*Sonik*)

- audible section of the bandwith of sonicity (acoustic sound) is just the phenomenal top of the iceberg above the water level, comparable to the visible part of the electromagnetic spectrum (what animals perceive as "light"). Sound as epistemological form of timing rather 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 historiographic writing) used to be narratively organised in the name of "history"

- not confuse such deep analysis with acoustic-oriented sound studies as a method in musicology and cultural studies; term *sonicity* introduced as neo-logistic way of claiming insight into the epistemological potential of sonic expressions. In its technological articulations, sonicity as a form of cultural engineering goes far beyond auditory culture

For the visual regime (notably cinematography), methods and software of stastistical "big data" research and sorting has been developed under the name of "cultural analytics" (Lev Manovich). A critical survey of parallel sonic analytics has still been developed only marginally. The target of sonic analytics is not speech or music as semantic content, but first of all the very materiality of such cultural articulation.

- range of chrono-poetical dimensions of implicit and explicit sound

- temp*aural* memories (the role of historicity, recollection, recording and archives in sonic culture)

- sono-epistemologic kernel of the Homeric Siren myth

- techno-sonic trauma; sonicity affects and irritates human time consciousness

- the ahistoric momentum in sonic experience; musical temporalities as exception from history

- from sound signals to alphanumeric symbols; digital return of textual "scores" into the sonosphere

- archaeonautics of sound: sonic analytics within big audio data and new options of algorithmically navigating them

- with a term borrowed from computer programming, "recursions" not simply

historically situated variations but rather challenging the historical order of events itself as technologically implemented chrono-automatism; demands thinking media in technological terms / through (active) media (archaeology)

"sonic" illustrations?

- printed texts necessarily exclude sound matter - even if, 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"

- a sonagram (spectrum analysis) or sonogram (ultrasound-based visualization) keeps 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

- autor speaks 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"; produced with open access Audacity software, the visualization (screenshots) of this phonetic statement a) as spectrogram (the numerical, mathematical, "digital" analysis) and b) as waveform (the "analogue", time-based form); sonicity not just metaphorical, but rather self-expressive

- spectrograms differ in unfolding on the y-axis: spectrogram linear, the other *logarithmic*: deeper frequencies can be represented on more "ground" than the higher ones, corresponding with human hearing

Electro-acoustic time-stretching

- within 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"[53]

- timestretched sampling, in spite of stemming 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

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53 Steve Goodman, entry "Timeline (sonic)", in: Matthew Fuller ed., Software Studies: A Lexicon, Cambridge, MA (MIT Press) 2008, 256-9 (256)

Bergson’s conception of *durée* itself.[54] While the temporal frame of the timeline in digital applications allows for linear orientation on the time axis, a more fundamental potential of sonic temporeality is embedded in the apparently un-Bergsonian realm of techno-mathematical "discrete time sampling" (Goodman). In accordance with the Nyquist / Shannon Sampling Theoreme, "durational time" ironically emerges out of the most discrete micro-temporal segmentation.

- composition (online) 24h Leif Inge, *9 Beet Strech* (Beethoven's "Nineth", slowed down by granular synthesis / Gabór's "acoustic quanta"); Jem Foiner, *Long Player*; reverse combinatorics: Benjamin Heidersberger, *Pentatonic Permutations Player*

- sounds like time-stretched (John Cage composition for organ, installed at Halberstadt ASAP = As Slow as Possible), but once computationally sampled, no time at all (rather *Kehrwert* of waveform = time signal, into frequencies = numeric algorithms)

- rhythm manipulation in Ableton Live: "The snare drum that was played on beat 1.2 is late. This rhythms was played by a real drummer, and he happened to hit the snare 'in the pocket', a term for playing a little late. While this beat feels great by itself, we will run into problems when we start layering other rhythms of clips with this one. [...] What we need to do is move the snare so that is plays just a little earlier. [...] So that's the way we use Warp Markers to bring our various loops into sync with one another" = quote from *online* presentation of audio editing software Ableton Live

- sampler allows for playing a "virtual" instrument which is not materially ready-at-hand

[further notes on "sonicity"]

- whenever listening to phonographic recording, a "sense of ending"; listener always already knows that the piece, the performance will end. When the pick-up of the record player is 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

- Theodor W. Adorno = Theodor W. Adorno / Hans Eisler 1976b: 75 f. insists: the apparently smooth integration of sound and vision in movies on a subliminal level is perceived as an irritating rupture; "schizophonia" (Murray Schaeffer) since the voice does not come from the visually projected bodies itself

- non-human: "technical media are media of non-solid, non-phenomenologial worlds (electro-magnetic fields, high-level mathematics, speeds beyond human comprehension"[55]

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54 See Henri Bergson, Creative Evolution (1907) trans. Arthur Mitchell (Mineola, NY: Dover Publications, Inc., 1998), 4

55 See the chapter "Non-human media", in: Jussi Parikka, What is

- media-archaeological = sub-phenomenological "acoustic quanta" as time-object (Gabor) vs. higher levels of sonic dramaturgy = "musical" ordering of time

- McLuhan does not sufficiently differentiate 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"[56]. 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 switching relais*, 19xxx); a different kind of textuality returns.

- sonic knowledge within waves: expressed in German as kind of Wagnerian alliteration: "Vernimm der Wellen wägendes Wissen"; Leibniz on *pétits perceptions* (subliminal) which unconsciously analyze a breaking wave into its single components

- nature calculating itself: the sound of breaking waves; walk on the beach: sound of breaking waves suddenly triggers reading memory of a passage from a late 17th century text. In his *Monadology*, philosopher Gottlieb Wilhelm Leibniz describes the archetypal moment: When listening rather subconsciously to the sound of waves, he seemed to be able in this noise to hear the physical wolrd calculate itself infinitesimally; pebbles / *calculi*

- "the analytical properties of the ear cannot be explained entirely in terms of the mechanics of the cochlea": J. T. Allanson / I. C. Whitfield, The Cochlear Nucleus and its Relation to Theories of Hearing, in: Colin Cherry (ed.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 269- (269)

- "Van-Eck-Phreaking": see 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

- Jenny borrows 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

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Media Archaeology?, Cambridge / Cambridge, Mass. (Polity Press) 2012, 55-61 (62)

56 See Herbert Marshall McLuhan, Kultur ohne Schrift, in: Martin Baltes / Fritz Böhler / Rainer Höltschl / Jürgen Reuß (eds.), Medien verstehen. Der McLuhan-Reader, Mannheim 1997

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)

- sonic dimension goes beyond the limitations of what human ears can recognize; approach to theorizing sound that investigates its split existence: as a temporal effect in a techno-cultural context and as a source of knowledge and information; term ‘sonicity’ that allows to consider sound with its physical, philosophical, cultural and techno-mathematical valences

- "implicit sonicity” explaining the ways sonic metaphors and tools structure other media; also linked to mathematically derived sound and sonic instruments

- privileged nature between sound and technological media is grounded in their analogous time-basedness

- 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; “sonicity” = acoustic/sonic/musical distinction

- Mara Mills’ articles on the history of the sound spectrograph: Mills, Mara: Deaf Jam: From Inscription to Reproduction to Information, Social Text 102: The Politics of Recorded Sound (Spring 2010): 35-58, and Mills, Mara: The Audiovisual Telephone: A Brief History, Handheld? Music Video Aesthetics for Portable Devices, ed. Henry Keazor (Heidelberg: ART-Dok, 2012), 34-47; "optophone"

- "drone" music = use of sustained or repeated sounds, notes, or tone-clusters; characterized by lengthy audio programs with relatively slight harmonic variations throughout each piece; analogue correlate to compositional "minimal music"; La Monte Young, in the 1960s, defined drone sound in 2000 as "the sustained tone branch of minimalism"

- on “drone” and “resonance”: Jean-François Augoyard / Henry Torgue (eds.), Sonic Experience. A Guide to Everyday Sounds [French original 1995], Montreal & Kingston, London, Ithaca (McGill-Queen’s University Press) 2005; *online*: http://xenopraxis.net/readings/augoyard_sonicexperiencecomplete.pdf

- aspects of coding, compression, etc. derive from telegraphy or communication engineering ("entropy"), not from the sonic sphere

Ontological vs. sonic "beeing" / "being"

- 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 suddenly makes sense in a sonic context: "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" = Viola 1993: 26

"Improved Terpsitone" (Teremin / HU)

- "Foreword" Liam Cole Young to W. E. *Sonic Time Machines*: "In Sean Michaels' 2014 novel [...], a fictionalized Lev Sergeyevich Termen describes his most famous invention: 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" = 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 signal audible to human ears by integrating two electric oscillator frequencies. "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, lingers.

- 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. Since Media Studies at Humboldt is not an art school but academic media epistemology, we not only re-built this amazing form of intuitive "sonic" interface, but presented 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

DISOVERING THE EARS ON FLUSSER'S FACE

- Flusser in his Sao Paolo lectures on music directs attention to the machine-induced noises of the modern world like "the syncopated rhythms of machine levers" and of "typewriters" which replace 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

- on Flusser's lectures on (electronic) music in Sao Paolo, 1965, Zielinski "pleaing for [...] a necessary contextualization, when it comes to >revisions< and similar dramatic changes. I hope that somebody is doing this serious media archaeological work around the time of the second half of the sixties [...], a period in which the FLUXUS movement with all its new inventions of processe orientated arts, discovering of new sources for intentional sounds etc. was already over ist climax"= e-mail Siegfried Zielinski, 24. Januar 2014;

Foucault, Archaeology of Knowledge = de-historizing, rather reconfiguration of discursive enunciations into series

- Xenakis regarding programmed and electronic sounds after the second world war: "We are all Pythagoreans"; after World Fair of 1958 foundation in Paris Studio *CEMAMu* (Centre d'Etudes de Mathématique et Automatique Musicales); generated with UPIC-Programm (Unité Polyagogique Informatique du CEMAMu) graphical curves curves, drawings; parallel Meyer-Epplers physico-mathematically founded sound and informational aesthetics theory; cybernetic epistemology; much of knowledge regarding the principal relation of mathematics and music accessible on high levels of reflection "in einschlaegigen dictionaries, handbooks, encyclopaedias for the history of sciences and technologies, musicology etc., f. e. in the Encyclopaedia Britannica, which the Flussers posessed or Vilém definitely used (we only still have bits and pieces of those in the archive, and Edith one told me that the BE was his Lieblingslektuere) ..."= E-mail Siegfried Zielinski, 24 January 2014

- in the 80s, Flusser on the "musicalisation" of the visual arts from a symbolic perspective; musical code / language both concrete and abstract at the same time - music, like mathematics, an abstract code, here intellectual process = "pure music"; Flusser later includes this perspective into his theory on the technical apparatus / media art: "[T]he new artist is led to return to the common roots of art and science, from which art was born. But what is even more interesting is the fusion between the visual arts and music, which is imposed on the artist. The visual codes become spontaneously "musical" ones, in that they no longer mean the outside world, but inner, mental processes"; media artist "transposes the processes of his brain onto apparatus" = 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)

- originality of Flusser's comments on "pure music"; cp. approach in Günther Stern's (alias Anders') habilitation effort around 1930: non-historist understanding electro-acoustics which is the power of the "musical" impetus itself

- radical diagnosis on the ahistoric "ecstasis" of musical temporality see Günther Stern's (*alias* Günther Anders) unachieved habilitation thesis, Philosophische Untersuchungen über musikalische Situationen, typescript (1930/31), Literary Archive of the Austrian National Library (Vienna), no. 237/04

- Flusser's enthusiastic correlation of music with mathematics; "pure music" - freed from discursive (aesthetic, cultural or religious) restrains - situates humans in a non-historicist tempor(e)ality in itself - a truly structual, therfore 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 - not in the sense of oral poetry, but rather in a deeper sense of *epistemé mousiké*. Logocentrism does not need to be deconstructed any more but gets (algo)ryhtmicized. Flusser defines music as "any set of sounds purposely composed by the human intellect" <Lecture 16>; at the same time he clearly separates between music as epistemic structure and its physical

implementation as audible sound.

- Renaissance perspective within the image turns out in musical scores: "the attempt to geometrize music and make it independent from lived experiences, to transform it into pure structure" <Lecture 16>. This festure of the modern Eurpean mind culminates with genuinely 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 celebrates electronics as a cultural form induced by technologies based on the electro-magnetic field. The magnetic recorder is 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. The sound is almost indifferent. It 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.[57] 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 correlates the options of electronic music with non-Euclidean geometry as much as McLuhan does in his later work.[58] A kind of sonification might transpose mathematical equations onto tapes, just as a techno-mathematical theory of music has been developed by the avantguarde engineer of digitally controlled analog synthesizers Erkki Kurenniemi.[59]

- 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 envisioned the post-

57 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.

58 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

historic age; here he longs for the ahistoricity of techno-structural sonicity. Training in listening to electronic music will help humans "to grasp the beauty of pure thought" <ibid.>. It is the "pure sine-tone" (Eimert / Stockhausen) oscillator in electro-acoustics and the binary computer for digital music composition which 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 radical analysis of the musical situation of the digital media age; his clear differentiation between the symbolic regime of musical mathematics and its temporal implementations as sound leads directly to a media archaeology of sonic articulation

LET THERE BE 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

- radical aesthetics, beyond "social" interaction (human-human), encompasses human-machine and machine-machine

- "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

Non-semantic expressions of media theory (and the rhetoric of „beyond“)

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59 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

- 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 mathematical codes, is 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, there is a „beyond noise“ turn now: not a re-turn to melody though (or referentiality or narrative), but to structured, patterned ways (Roslind Krauss) of presenting data clouds; is it the limits of hardware which still insists on the irreducible noise of matter

***Bruits* vs. Pythagoras**

- theatre subjected noise to language; beyond the „language“ of new media, noise has media-theoretical knowledge itself

- musical composition (different from physical sound) does not need recording on magnetic tape, gramophone or Compact Disc (the age of reproduction / repetition); sufficient if generative algorithm can be located, to re-generate

- media-theorization of sound, that is: a move from writing *about* music to *writing musically* (thus „repetition“ and „composing“ as subject becomes his own writing style as well), in order not to explain music successively but to think with it: „Mon intention n´est donc pas ici seulement de théoretiser *sur* la musique mais de théoretiser *par* la musique[60]; writing *with* music

- with digitally processed sound which is mathematical space = return to the archaic Greek paradigm? While Pythagoras pre-supposed a mathematical order of the universe, which he found in musical harmonies, the relation between astrophysics and musicology nowadays is a different one. Radio-telecopes, for example, register rather noise than harmonies from deep space; there is no (more) "soul" as a medium of processing sound into harmonics

Media immediacy by noise?

- video *still* Viola, Information (1973), is only a slide, which shows photo-chemical noise of analog video; noisy computr screen (would already process noise)

- noise a way of sensually experiencing communication theory (Shannon)

- noise as a specific expression of something only eletrocnic media can record, give access to

- acoustic processing „brings us into direct contact with the unpersonal“ (Steve Reich); „die Hingabe an den musikalischen Prozeß ermöglicht eine Lenkung der

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60 Attali 1977: 13; cp. Gregory Ulmer, Teletheory. Grammatology in the Age of Video, New York (Routledge) 1989, xii

Aufmerksamkeit weg vom *Er*, *Sie*, *Du* und *Ich* hinaus zum *Es*[61] / end cMUSIKARC

- media archaeological aesthetics, which Attali deciphers for composers like Xenakis: *dépersonnalisation*, „vide de sens“, without code <1977: 185>, that is: re-archeologizing the sound

- Etruscan *phersu* / Roman *persona* as mask; the „human“, face-like interface

- in article for the *Revue internationale de Radioélectricité* in 1935, M. Bollecker distinguished „radiodiffusion“ (the transmissal of waves across space) from „reception“ with means the transformation of these radio waves into sound = Attali 1977: 162

Disturbance, interference, break-down: Let media speak (I)

- noise (*eigenrauschen*) as acoustic evidence of the medium is hidden, suppressed, by so called messages and interfaces. But every once in a while, in moments, of technical breakdown; this disruption positively recorded in experimental music

- noise generated as impulse for Techno music from *analog* synthesizers

- the materiality of hardware which noisily re-emerges as 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

Noise: the gospel of media theory?

- noise itself has become something like the communication media´s message

- *The language of new media* (Lev Manovich) "language" only with programming source code, but something which eludes semiotics: noise, ruptures. Perice´s triadic, relational semiotics already transcends the traditional, dichotomically signifier / signified-based semiotic dimensions of noise. De Saussure „plaquait une sémantique sur les sons“ <Attali 1977: 45>. Only in moments of technical break-down, according to Martin Heidegger, the medium speaks, reveals itself behind the surfaces, interfaces

„Message ou bruit“? Noise with Foucault

- Lauri Siisiäinen, Foucault and the Politics of Hearing, New York (Routledge) 2013, chap. "Message or Noise", 31 ff.

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61 Steve Reich, "Musik als gradueller Prozeß", in H. Danuser, D. Kämper, P. Terse (eds.), Amerikanische Musik seit Charles Ives. Interpretationen, Quellentexte, Komponistenmonographien (Laaber, 1987), 288-290 (= "Music as a Gradual Process", in: Steve Reich, Writings about Musik, Halifax / New York, 1974), and biography 373 f.

- Foucault´s *Archaeology of Knowledge* belongs to the age of repetitive, patterned, serial music (Barraqué)

- "Message ou bruit"? Foucault once asked with respect to medial diagnosis and psychoanalysis of symptoms

- noise and "anti-noise": "Signal to noise" ratio, noise (or chaos) vs. order, low-frequency and low-amplitude noise, noise and silence.

- John Ruskin cultivates the photographic image surface aesthetics which is diffractive distribution of photo-chemical noise / silver halogenite grains / crystalls, literally: "We *see* nothing but flat colours; and it is only by a series of experiements that we find out that a stain of black or grey indicates the dark side of a solid substance, or that a faint hue indicates that the object in which it appears is far away. The whole technical power of painting depends on our recovery of what may be called the *innonence of the eye*; that is to say, of a sort of childish perception of these flat stains of colour, merely as such, without consciousness of what they signify, - as a blind man would see them if suddenly gifted with sight[62]

Data clouds

- While clouds are spatial schemes, noise is a *time-based* event, that is: it can only be perceived in a dynamic process, never ever at a single given moment or *punctum temporis*, against visual-spatial perception

- sampling = 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: analogous to imaging sciences, there are sounding devices

Beyond noise? Discrete numbers

- mathematical stochastics = calculating with noise, literally

- while computer can not tell meaningful from meaningless information, noise for human eyes and ears only. Being a deterministic system5, the Turing Machine does not know noise; it can only simulate preuso-noise

- Digital codes result in a loss of noise; at the same time, they seemingly (to human eyes and ears) make noise visibly / audibly analyzable; by always already translating it into information, just like aarchaeoligists by the very act of excavation translate the material noise opf physical remains (decay) into coded sulctural signs: order from noise

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62 John Ruskin, the Elements of Drawing (1857), in: ders., The Works, hg. v. E. T. Cook / A. Wedderburn, Bd. 15, London 1904, 27

like the analogue/digital converter in computing. the physical noise input thereby is reduced, impoverished to finite, thus calculable bits; thus the quality of a piece of music digitally processed becomes a function of storage economy and volume - in the sens of Attali´s economy of music. Noise is costly, here -

- While analogue computers are based on electric mechanical or chemical signals in the physical world which always transport background nosie as well - and be it the Browne movement of molecules in the channel (f. e. telephone line), the signal-to-noise-ratio is always inprecise <Hillis 2001: 84>. In noise, the material world speaks: beyond information. With noise , the physical world parasitically (Serres) participates at the discourse by undermingin logics / digial forms (Boole´s logic). To this respect, noise knows more abput the real world (or should I say aboput the world of the real, that is, the symbolically incalculable? We can experience it in computers: 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): "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."[63]

- errors in *live* TV transmission of coronation queen Elizabeth II. 1953; VIDBO

- breakdown TV image Ceaucescu

- audio / visual noise a media-archaeological reminder of media immediacy: message or noise?

- noise can not easily be classified in archives, since it eludes classification. Without a musical script (Partitur) or notation system, many music compositions of that kind are being refused by the music departments in national libraries, since the classification systems are unable to cope with noisy compositions

- alternative is not order *versus* noise; the challenge to noise is different. Noise is a term derived from the analogue world; in digital topologies, there is (almost) no noise / digital data processing allows for no noise, filtering it out.

- 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."[64]

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63 Richard Dienst, Still Life in Real Time. Theory after Television, Durham / London (Duke UP) 1994, 20

64 Neil Gershenfeld, The Physics of Informatic Technology, Cambridge (UP) 2000, 222

- 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*?

- Don DeLillo, *White Noise*: fear of death as entropic state

- John Cage who made it clear that there is 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. If we listen carefully, this is true for the computer as well: With no operation by the human user, the machine audible runs in order 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.[65] *White noise* does not mean nonsense, but a ceaseless particle stream of information in constant motion.[66] Indeed this metaphor 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 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."[67]

- Photoshop post-production options: remove / add noise; against the aesthetics of Photoshop image manipulation

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65 Walter Moser, Eppur si muove!, in: Goebel / Wolfgang Klein (Hg.), xxx <Festschrift Lämmert>, 1999, 238

66 Edouard Bannwart / Daniel Fetzner, Reflexionen – die Wissensmembran, in: Ausstellungkatalog *7 Hügel / VI: Wissen*, Budde / Sievenich (Hg.), Berlin 2000, 27

67 Richard Dienst, Still Life in Real Time. Theory after Television, Durham / London (Duke UP) 1994, 20

- In technological noise and channel noise, the medium reveals itself (with Shannon's definition)

- no total (white) noise; „noise“ is 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) is a hermeneutic or aesthetic abstraction, since it does not exist physically

- digital regime, with its mathematical codes, is 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): The digital realm, with its mathematical codes, is noiseless in itself; noise there just turns 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.

- after avantgarde-liberation of sound from music, of emancipating noise in explicitely sense-less (nevertheless sensible) ways, a „beyond noise“ turn now: not a re-turn to melody though (or referentiality or narrative), but to structured, patterned ways (Roslind Krauss) of presenting data clouds. Or is it the limits of hardware which still 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) would destroy the fragile equilibrium of relational qbit states = Hillis 2001: 95

Beyond noise? Breaking waves

- human eyes and ears tend to overlook and overhear noise as information = Harris 2001: 122; reverse: making sense of meaninless stochastic patterns (Electronic Voice Phenomenon); otherwise compressing algorithms for streaming data in computing would not be acceptable. Only with human hermeneutic preference for Gestalt, the filtering sacrifice of noise is justifiable. But non-human senses are more sensitive to noise, and we have to admit that communication happens not only between humans any more, but in an emerging intelligence called "the Web".

- only possible to speak *about* noise; articulated and alphabetic (phonetic) language unable to speak noise transitively, like some poets sometimes have tried. What would be the onomapoetics of noise? noisy articulation; temporal *noise* opposed to "historical" code; navigation in non-hermeneutic spheres

- Leibniz, in the breaking waves at sea shore, hears nature calculating (integrating / differentiating) itself, *nesciens* calculating ("sampling") perceived

sound waves. But the 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. Now we reach the noisy limit of the digital computer: Although materially built on sand (silicium), he is not able to calculate the random distribution of sand (otherwise aliasing effects). 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

ARCHAEONAUTICS OF SOUND. "Cultural analytics" within the sonic field

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-archivological side

- Current audio analysis software creates predominantly visual interfaces (waveforms, spectrograms), as indicated by the very name of Sonic Visualiser, representing time, frequency and energy of the sonic event

- Richard Beaudoin, The Principles of Microtiming and Musical Photorealism, manuscript http://nrs.harvard.edu/urn-3:HUL.InstRepos:3415685

[a JPEG file on hard drive. "There's visual information there, but it cannot be *seen* until interpreted by a piece of software that projects or prints an *image*" dynamically = Beaudoin / Kania: 122]

- instead of automatically generating metadata out of the sound material (the logocentric appraoch), learn to 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 already: automated semantic music analysis[68]

- 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*

68"Musikbezogene Metadaten", as expressed by Holger Großmann, Fraunhofer Institute, Ilmenau

time

- Sonic Visualiser allows 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"[69]; further allows for detailed analysis of performance timing[70]

- Spectrograms come into their own "in the analysis and interpreation of expressive gestrures at a relatively detailed level" (Cook / Leech-Wilkinson)

- tools for navigation in online audio platforms like *Soundcloud.com* with their wave form representation of the song actually heard; allows for the visual feedback in realtime and orientation in large audio data. Not only sound processed by digital media can be analyzed like this; actually the "sound of media" themselves is accessible thereby[71]

- In 2003, Vodafone mobile phone provider offered an 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)[72]

- media-artistic application: Dumb Angel by Klaus Gasteier (KHM Köln)[73]

- MARSYAS = Music Analysis Retrievl and SYnthesis for Audio Signals = free software framework "written" by George Tzanetakis

- music information retrieval (MIR) = non-verbal mode of accessing music archives - once they have been digitized, that is: beyond the signal - operates from within the sonic matter, "based on musically substantive features such as chords, motifs, rhythms, etc."[74]

- not the one and only aim of digital archives to automatically generate metadata out of the sound material, but to learn to navigate within the signal space itself, without logocentristic metadating. In signal compression formats

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69Nicholas Cook / David Leech-Wilkinson, A musicologist's guide to Sonic Visualiser, <URL?>

70 See Jopsé Bowen, Tempo, Duration, and Flexibility Techniques in the Analysis of Performance, in: Journal of Musicological Research 16 (1996), 111-156

71 See http://soundcloud.com/mediensounds

72 Note "Erkennen Sie die Melodie?", in the Berlin program journal: zitty 21/2003, 80

73See "Dumb Angel. Brian Wilson wird interaktiv", in: SPEX 9/1996

74 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*)

like MPEG7, though, the metadata and the sampled signal data are 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*" italics W. E.; "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 are useless. "La transformation de l'`archivistique´ est le départ et la condition d'une nouvelle histoire"[75]

- Franco Moretti in his Distant Reading: “[O]ne cannot study a large archive in the same way one studies a text,” he writes; texts are designed to “speak” to the reader; but archives are not messages that were meant to address us; so big data say absolutely nothing until one asks the right question.

- In audio data "mining", the media-archaeological element is addressed directly; the Databionic MusicMiner, developed at the University of Marburg, heavily relies 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" opens between the hermeneutic approach (cultural "understanding", musicology) and the explicit measuring approach (enhanced by appropriate instruments); measuring melodic similarity, human *versus* algorithmic judgements clash[76]; 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

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75 Michel de Certeau, L'espace de l'Archive, in: Traverses 36 (1986), 5

76 Daniel Müllensiefen / Klaus Frieler, Measuring melodic similarity: human *versus* algorithmic judgements, in: Conference on Interdisciplinary Musicology, Proceedings CD-R, Graz

- Predictive Analytics today: "Dazu sammelt man Daten und durchsucht diese mithilfe von Algorithmen nach Regelmäßigkeiten, die man dann in die Zukunft extrapoliert"[77]

- different from hermeneutic understanding (German *Verstehen* resonates with its acoustic sense) 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"[78] - auf jenem "rather microscopic level on which I want to consider it" <ebd.>. "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"[79]; *sonic diagram* replaces the visual interfaces (dominating human-computer-communication in audio analysis)

- A decisive assumption for sound analytics is 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

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77 Entry "Predictive Analytics" in the *Glossar* of Heinrich Geiselberger / Tobias Moorstedt (Redaktion), Big Data. Das neue Versprechen der Allwissenheit, Berlin (Suhrkamp) 2013, 301

78 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)

79 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)

- sonic signals previously required 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; but primarily this automated analysis gives access to the temporal realm of the sonic event by identification of micro-temporal structures, beats and rhythm. The real time components of such a software creates waveforms to be analyzed by 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). This can be applied to even higher levels of sonic dramaturgy (which is the culturally familiar "musical" ordering of time)

- Denis Gabór proposed "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 will no longer list 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[80]

- the coding of body movements or facial expressions involves the development of units that, while easy to see, are difficult to describe adequately ithrough a 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"[81]

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80 For an "open access" data bank to experiment with, see the Freesound Project, and more media-archaeologically the *online* collection of "endangered sounds"

81 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

- 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"[82] - genuin "info-aesthetics", according to which the degree of surprise corresponds with the measure of informative quality[83]

- services ("Apps") like Last.fm learn to detect and then to automatically propose 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 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. Once more, the very term "music" seems almost identical with human, culturally trained listening; musical knowledge (*mousiké epistemé*) might be equally 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) declares that what is required is 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 transforms from the passive memory institution to media-active subject of search; search enginge itself becomes an archaeologist of cultural knowledge

- "a 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"[84]

- "Symbolic formats can be contrasted with audio formats which,

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analysis, New York (Wiley) 1969

82 A commentator, in: http://blog.magix.com/de/archives/270-Mit-mufin-gibt-es-nur-noch-Lieblingssongs!.htm (accessed 12 May, 2009)

83 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"

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>

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[85]), and efficient algorithms "for extracting the repetitive strucutre of an audio recording"[86].

"The decision to use symbolic formats for our study lies in the fact that we are interested in objects of music cognition like melodies, rhythms, and harmonies, which seem to be mentally represented in a form comparable with symbolic encoding formats." <Müllensiefen et al., 133>

"The hypothesis is that cognitive processes like memory encoding and retrieval as well as similarity perception are influenced by the familiarity of the musical material that is to be processed." <Muellensiefen et al., 136>

- 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."[87]

"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

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84 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 (= Hamburger Jahrbuch für Musikwissenschaft 24), 133-153

85 See Müller 2007: 69

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

87 Muellensiefen et al.: 136

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."[88]

- "Distant hearing" 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; see Axel Roch, "Texte als Bilder über Signale lesen"

Search "within its own medium": Towards content-based retrieval

- technomathematical knowledge; mighty algorithmic tools have been developed for "audio fingerprinting" purpose of copyright identification of "locating metadata for legacy audio content without metadata annotation" <Kim et al. 2005: xxx>; 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

- The literal transcription of audiovisual evidence into symbolic notation is 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"[89], allowing for a comparative classification of sound into general sound categries

- This content-based sound retrieval application explicitely offers algorithmic tolls "in combination with traditional keyword and text queries"[90]

- time domain description (by the audio waveform descriptor) as genuine option of multi-media archives, media-archaeologically revealing characteristics of the original music signal in its very sonic existence: the harmonicity of a signal, its tone quality (timbre), down to discrete segments of sound (a phonographic alternative to alphabetic symbolic "elementarisation", that is: analysis)

- spectral audio descriptors all derived from a single time-frequency analysis of

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88 Muellensiefen et al.: 136

89 Hyoung-Gook Kim / Nicolas Moreau / Thomas Sikora, MPEG-7 Audio and Beyond. Audio Content Indexing and Retrieval, Chichester (John Wiley) 2005, 2

90 Blum et al. 1997: 114

an audio signal[91], 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 - a kind of *incipit*.

- now possible to select or sort or classify sounds from a database using the distance measure. "Some example queries are: Retrieve the `scratchy´ sounds" = ibid., 121

The sonic difference to software for visual content analysis

- while specific analysis algorithms for audio differ from those found in image or video analysis systems, "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. [...])"[92]

- audio signals are radically (and essentially) functions of the time axis. The 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"[93]

Recording sound from the real world

- Barthes describes affective experience of looking at an ancient photography as *punctum* - a short-cut between past and the present. This is a punctual moment, while in acoustic recording by gramophone there is a processual, time-based signal. Its re-play generates a different sense of the past. 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"[94]

- 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

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91 Kim et al. 2005: 6

92 Blum et al. 1997: 114

93 Blum et al. ibid.

94 Ludwig Wittgenstein, here quoted after: Gregory Ulmer, Applied Grammatology, Baltimore (John Hopkins University Press) 1985, 110

gramophone groove[95]

- As engraved index (in Peirce's semiotic sense), a sound forms 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.[96] 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. The acoustic signal does not loose its temporal indexicality when being recorded

- experience of an approaching train when the longsounding whistle of the locomotive dramatically changes its pitch as the train passes by - a confrontation with a physical event: "Replicate that same sound on a recording and it will not lose its capacity to confront a hearer with the apparent motion of a large body, but will continue to index the direction and speed of an apparent object, without the train actually being present any more. The sound, taken away from the real event, retains its indexing properties"[97]; aggressive acoustic signal (intrusive on the body through the unsheltered, open ear) even in its media-technological reproduction seems to retain its physically *effective* and physiologically *affective* reality, being identical in terms of its frequency values? In real space, such a sound causes hearers to look immeditely for its source, opposed to "schiziphonic" (Schaeffer) sound coming out of loudspeakers from a technical record; response to the real non-narrative signal ceases to be decisive in the case of taped sounds? = Cumming ibid.

- Walter Benjamin identified a kind of "optical unconscious" which reveals itself only to the camera eye. Something analogous exists for sonic phenomena.

- phonographic records - however they have been part of discoursive, ideological. aesthetical and technical formations -, unintentionally have co-registered a whole world of additional information, starting from background noises; message from the past or noise? Edison wax cylinders from the beginning of the 20th century may very well contain background recordings of environments that were never entended for memory but now "recall (if an earlier event can recall a later one) the Soundscape Project in Vancouver and the admirable and current series, 'Metropolis', produced by Klaus Schoening in the Studio for Akustische Kunst at the WDR" = annluncement of seminar *Time waves goodbye* (directed by Anthony Moore / Peter Kiefer at Academy of Media Arts, Cologne, summer term 2000 (Sound Laboratory). "Mr. Z." = Siegfried

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95 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

96 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)

97 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)

Zielinski; see his *Medienarchäologie* (Reinbek 2002)

- 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, (or three if you take into account the now-time you are listening in, which is always changing)" (Moore / Kiefer). It is the media-archaeological intention to dig into collections of early recording machines in such a non-historical way (anti-hermeneutically). Out of this archaeological site develops a different "hearing modern history"[98], a notion of the sound of the past "based on waves, simultaneous time and shifting soundscapes.[99]

Media as active archaeologists: SpuBiTo

- Real archaeologists of sound past are the media themselves, but 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.[100] 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

98 Such has been the title of a conference undertaken in Berlin, June 2010, xxx

99 See Tony Schwartz, The Responsive Chord, New York 1974 <?>

100 See Gerd Stanke / Thomas Kessler, in: Simon (ed.) 2000: 209-215

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 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 does not damage the unique negatives, therefore allowing for a truly *archival* reading. The 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 issolves any meaningful unit into discrete blocks, which are accessible for human analysis only by operative techno-mathematical diagrams. This is an analytic, media-archaeological form of deciphering the sound of the past

- television images transmitted as electro-magnetic waves, with "the fluctuations being determined by the shape and / appearance of the obhject 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 correspinding '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 toriginal 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

Acoustic archaeology

- Edison wax cylinders from the beginning of the 20th century contain 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[101]

- 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 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 change 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

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101 See Tony Schwartz, The Responsive Chord, New York 1974 <?>

- "[...] numerous attempts have been made to develip taxonomies of sounds, inculding musical and environmental sounds."[102] Dynamic algorithmic access replaces the static classification of the traditional catalogue. From this results an archival challenge: the need for a flexible tool which allows for the 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

- discovering and reflecting upon (and techno-mathematically realizing) new technologies of memory by algorithmic access; searching for sound by sonic parameters, for images by optical values, just as archivists use to search for names and characters by names and characters

AURALIZATION AS (RE-)ENACTMENT OF THE SONIC PRESENT / PAST

Sonic Media Archaeology

- transmitting sonic information to future ages by coding (Carpo: Alberti), allowing for a later re-sonification, not by direct audification (like the phonographic record) but in terms of parameter mapping[103], 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[104]

- 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

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102 Thomas Blum et al., Audio Databases with Content-Based Retrieval, in: Mark T. Maybury (ed.), Intelligent multimedia information retrieval, Cambridge, Mass. / London (MIT) 1997, 113-135 (115), referring here to Schaeffer 1966 and Schafer 1980

103 See Thomas Hermann / Andy Hunt / John Neuhoff (eds.), The Sonification Handbook, Berlin (Logos) 2011

104 "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)

voice to the image; http://vimeo.com/30238729; with sound: 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

- "Helmholtz resonance" in archaeological spaces: standing waves

- 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)curs (equi-temporally) by electro-mechanical, technical, afterwards computational means: generative echo resp. reverb, *without bodily source*

- sound is signal rather than signs; "sonicity" = implicit sound, non-human dimension of sound

- Anthony Hempell, "The Resonating Interval. Exploring ..."; McLuhan differentiates 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 the 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[105]

- 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"[106]

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105 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)

106 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

- McLuhan recalls one of the sessions of his Toronto Culture and Communication seminars, when the psychologist Carl Williams intervened in a discussion on enclosed (architectural) space: "After all, the spaces inside a pyramid, even thozg dark, could be considered as acoustic spaces, and he then mentioned the characteristic modes of acoustic space as a sphere whose centre is everywhere and whose margins are nowhere <...>. I have never ceased to meditate on the relevance of this acoustic space to an understanding of the simultaneous electric world"[107]

- wave field synthesis; argument was taken up by a pacticing radio journalist, Tony Schwartz in 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"[108]. "Resonanz ist der Modus des akustischen Raums" <McLuhan 2002: 213>

- broadcasting media differ from global communication of today (the 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

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107 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)

108 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)

"electronically mediated human communication" (Schwartz) - a term to be preferred against the simplifying notion of *audio-visual media*[109] - 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 for sound, but also for electronically mediated visual information, which is patterned like auditory information" = Schwartz 1974: 13

Articulation in "sonic" time: resonances

- *syn-aisthésis* as "sympathetic sensation" reminds not only of cross-modal metonymies but as well of sympathy within the temporal field, known as the phenomenon of resonance (which always involves transfer of energy as well)

- 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 re-played in real-time, thus invariant to the delay in physical, "historic" time which has elapsed between the recording time and the time of re-play

- acoustic space without center; it consistes rather of infinite resonances[110], "it is this dynamic state to which the human brain responds in a privileged way since its own internal timing processes are oscillatory to a high degree.

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109 See Michel Chion, Audio-Vision. Sound on Screen, New York / Chicester (Columbia UP) 1994 [Frz. Orig. L'Audio-Vision, Paris (Nathan) 1990

110 See Friedrich Cramer, Symphonie des Lebendigen. Versuch einer allgemeinen Resonanztheorie, Frankfurt a. M. / Leipzig (Insel) 1996

"*Resonance* refers to the tendency of strings, <...> colums of air confined in pipes, bells, and numerous other objects to vibrate in an ongoing manner determined by the details of their physical structure. Depending on the frequency components of these ongoing vibrations, longer-lasting stimuli can generate the perception of a *tone* if the vibrations are relatively coherent, but are perceived as *noise* if they are incoherent" <Purves (ed.) 2008: 152> - the mechanism of vocal-consonant speech, between pure tone and white noise

- McLuhan insists: 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 [...]"[111]

Research into synesthetic mixing of the senses inevitably leads to questions of synchronization between sensory and signalling pulse trains; there is a privileged affinity of the auditory (or sonic) sense resp. channel to the frequencies of nerve cell signaling, as opposed to visual signal processing

"Although not found in nature, a sine wave stimulus is 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 belong to the mechanical world, while light is within the range of the electro-magnetic spectrum, thus being a completely different quality. In a certain sense, 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).

- media-induced temporal affects

- sound waves and light converge in their common analysis as periodic events, counted in frequencies, 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[112]

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111 See Viktoria Tkaczyk, The Shot Is Fired Unheard: Sigmund Exner and the Physiology of Reverberation, in: Grey Room 60, Sommer 2015, 66-81

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

- kind of "theoretical synthaesthesia" takes place, once the "video as a virtual image" is discovered in its "vibrational acoustic character" = Viola 1990: 44; "optophonic" transfer, audio-visual metonymy. This is 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.: electric signals coupled with loudspreaker, still within human audible range; this suggested association with sound regording (gramophone), resulting in storge 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 subsumed 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> - being closer to the electro-chemical transduction within human eyes and ears when communicated to the brain.

Such a kind of technology *resonantes* with the human perceptual mode in a privileged ways; McLuhan / Bruce Powers, The Global Village: chap. "resonant interval"

- "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.
All the notes and possible notes to be played are present before the main musicians even start playing, stated by the presence [...] of the tambura. A tambura is a drone instrument, usually of four or five strings, that, due to the praticular construction of its bridge, amplifies the overtone or harmoic series of the indivual notes in each tuned string. It is <...> continually present throughout" <ibid.>.

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112 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)

- acoustic delay (the echo effect) led Aristotle to discover the "medium" of a category in itself, the "inbetween" (*to metaxy*)[113]; ancient Narcissus myth: he saw his image immediately mirrored in the water, while the echo unfolds in time

- ultrasound itself = sort of dynamic memory (in suspense), as being 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."[114]

Ultrasound between short-time memory and imaging

- Bill Viola, The Sound of One Line Scanning, in: xxx Lexier (ed.), Sound by Artists, xxx

- ultrasound imaging, known from medical diagnosis, itself is images based on sound, where the slowness of acoustic waves (echo delay) are used to create electronic signals which can secondarily be transformed into sound (by sending them to loudspeakers); sound phenomenologically not experinced directly (bin-aurally) but indirectly seen, as images

- ultrasound, by definition, transcends (above 20 kHz) the realm of acoustmatic sound which can at least be recognized within the audible range of the human ear, rather being part of what Marshall McLuhan named "acoustic space": electronically mediated communication; Tony Schwartz, The Responsive Chord, New York 1974

- different from visualised sound in cinema, here the inaudible sound is visually revealed; since the age of the sound film: the experience of "visual sound"

TOWARDS A MEDIA-ARCHAEOLOGY OF SONIC ARTICULATIONS

Still "sound"? The digitizing auf analogue audio carriers

- 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

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113 See Emmanuel Alloa, Metaxu. Figures de la médialité chez Aristote, in: Revue de Métaphysique et de Morale, vol.106, Heft 2 (2009), 247-262

114 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)

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). The Nyquist / Shannon sampling theoreme already allows 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.[115]

"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. Frz. Original (1966): Message ou bruit?, in: ders., Dits et Écrits I, Paris 1994, 557-560

Today: opto-digital reading of otherwise unaccessible sound recording; "Spektrogramm einer rekonstruierten Tonaufnahme (Wedda-Gesang, Ceylon 1907)" on the SpuBiTo web page

- opto-digital *close reading* of sound as image, dissolves any meaningful unit into discrete blocks

- media-archeaological re-enactment leads to a different temporal regime of auditory memory

A *media* archaeology of the acoustic

- track 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

- play a musical score on historic instruments: way of "acoustic archaeology"?

Architectural sonicity

- media-archaeological sound traces; past sonospheres bring us close to a media archaeolgoy 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 nature of sound propagation) and other technical dispositives now allow for the virtual (which is: counted) reconstruction of "historic" acoustic spaces

- virtual re-creation of the soundscape of, f. e., the city of Berlin around 1900; 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

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115 See http://www.iasa-web.org/IASA TC03/ IASATC03.pdf

- architecture not just an empty room-acoustic vessel, but the sound is actively processed by the acoustics of the space, by filtering out or amplifying certain frequencies in the sound spectrum. When the building is used as an instrument, it comes inbetween the classical music instrument and the disembodied electronic sound device; concept of using the building as an instrument inspired by Alvin Lucier's work *I am sitting in a room* (1969)

- Michael Harenberg, Zur musikalischen Ästhetik klingender Räume, in: Peter Kiefer (ed.), Klangräume der Kunst, Heidelberg (Kehrer) 2010, 125-138 (133)

- 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. Does historicity literally re-sonate on such spots? 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."[116] But acoustic archaeology manages to retrieve the memory of sound out of architectural spaces; Weinzierl

- "acousmatic" sound defined as sound perceived without seeing the sound-originating cause. When for *musique concrète* in Paris, Pierre Schaeffer, defined the "acousmatic" as "sound that one hears without seeing the causes behind it"[117], 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; our ears are *tuned* differently since. The positivist illusion of simulating past acoustic space is deferred by the more difficult task of reconstructing acoustic tempor(e)ality: time-tuned sound

- By auralization, architectural spatiality can be experienced as a time (signal) function - rather time-critical impulse response than static geometric perspective. There is 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. Did composers of organ music actually create works with respect to the echo (reverberations / resonances) created by the individual cathedral architecture? Would John Cage's piece *4'33 Silence* (intended for piano) create a different kind of silence when "played" on an organ in a

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116 Georg Wilhelm Friedrich Hegel, Vorlesungen über die Ästhetik III, in: Werke vol. 15, Frankfurt/M. 1970, 134f

117Pierre 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)

cathedral? Architectural space adds "media" *time* to the symbolic musical notation. Room acoustics is architectural sonicity in latency.

- Verständlichkeit der Sprache leidet erst bei übergroßer Nachhallzeit (mehr als 4,5 oder 5,5 s)[118]

- akustisches Phänomen Orgel / Kirche: an kahlen Stein-/Betonwänden die Schallqellen optimal reflektiert; höhere Frequenzen stärker absorbiert als niedrigere Frequenzen. "Mit dem Aushallen des Tones
kann es also schon deswegen zu einem Filtereffekt kommen"; niederfrequente Teile bleiben länger im Raum - delayed presence

- Once resonances occure within a room, they enhance selected frequencies, case organ in a cathedral[119]

- 3D-SketchUp-Modell or AutoCAD file; on that data basis, with EASE 3D-computer models, in which room-acoustic simulations can be experimented

- 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"

- archaeo-acoustics (both in its temporal and structural sense) actually analyzes the affinity of certain architectures to sonic articulation, especially sacred buildings.[120] From the sound-archaeological perspective, any resonating body is an artefact of sonicistic architecture. The difference between the media-archaeological approach (archaeo-acoustics) and the approach of cultural history (archaeology of music), here, is the former's focus on acoustic properties, whereas the latter focuses on cultural meaning ("music"). Whereas the sonic performances in ancient sacred architecture are silent (unless one accepts Charles Babbages' idea that any vibration does never cease completely, as expressed in his *Ninth Bridgewater Treatise* in the 1830s), media-active archaeology allows for virtual re-auralization of such archaeological spots.

- "Reverberation equations, sound meters, microphones, and acoustical tiles were deployed in places as varied as Boston's Symphony Hall, New York's office

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118 "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

119 http://www.wer-weiss-was.de/physik/akustisches-phaenomen-orgel-kirche; access 14 September 2014

120 See the research and publications by the music archaeologist Graeme Lawson, especially the Cambridge Music-archaeological Research website orfeo.co.uk

skyscrapers, and the soundstages of Hollywood. The control provided by these technologies, however, was applied in ways that denied the particularity of place, and the diverse spaces of modern America began to sound alike as a universal new sound predominated."[121]

- spatial, text-based archive known 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*

- traditional sonic experience in real archives is silence; historical imagination (as expressed by the Romantic French historian Jules Michelet) though hallucinates the voices of the dead here. The media-archaeological ear, on the contrary, is trained to actually stand archival silence, gaps, voids. But 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 is its sonicity.

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. Still there is not only implicit (sonicistic) but as well 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, we are actually listening to data music. What we hear is not sound as memory content like an old persussion-assisted song[122], 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.

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

A new way of experiencing the sonicity of computer-architectural space

- in terms of signal processing, physical architecture is space defined by material boundaries; can be experienced not only by the eyes which are disciplined by "perspective as symbolical form" (as expressed by Erwin Panofsky) but by binaural hearing as well. All of the sudden, space becomes a

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121 Emely Thompson, The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900-1933

122 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

function of time-critical sound vibration and propagation.

- "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 never hear a sounding object by itself, always an assemblage of sounding object and resonant space."[123]

A different kind of "machine" is at work here: "Acoustic resonance is a subset of mechanical resonance"[124]

- In architecture, this corresponds with reverberative time (the audio signal delay known as "echo"). In the case of ancient and medieval churches, "there is no mention of *intentionally* creating reverberation for its theological relevance"[125]; long reverberation as 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 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[126]

- architecture not just an empty vessel to be filled by arbitrary acoustics; sound rather actively processed by the architecturally defined space itself. This concept of using the building as an instrument has been inspired by Alvin Lucier's sonic explorations of architectural spaces. But it takes the memory capacity of an electronic device to provide fugitive sound articulation with a recurrent index of temporal depth, as realized in Ksenija Čerče's sound / video environment *rec # 21* in the former Judgement Tower at Maribor, Slovenia (summer 2011). An initial acoustic articulation is first being expressed in a closed room and is phenomena are being recorded. Then the recording is played back into the room, re-recording it. This new recording is then played back and re-recorded again many times (an operation well known from echo delay by magnetic tape players). In exploring a closed architectural space by means of acoustic pulses, signals are folded upon themselves. The second signal is a replica of the same information delivered within a temporal interval. Spatial extension thus thus turns out to be the medium of temporal

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123 Peter Price, Resonance. Philosophy for Sonic Art, New York / Dresden (Atropos Press) 2011, 20

124 Price 2011: 21

125 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)

126 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

delay, while at the same time space itself becomes a function of temporal measuring. For her installation in the Maribor Judgement Tower, Čerče thus repeated a sound sample 21 times in order for its acoustics to shape what she calls "the sound image". Here the artist de-couples what is known from the cinematic *dispositif* in which (since the age of the sound film) the relationship between sound and image is dramatically and technically coupled to violently merge both sensual modalities in the audience's perception. What at first glance looks like a visual projection turns out to be of a sonic, tempor(e)al nature, revealing the asymmetries of audio-visual media which time-critically fall apart.[127]

- transfer this sonic analysis from concrete architecture into the "flat" and condensed architecture of digital computing, the sound we can experience is of a different kind.

- essence of digital computing is the literal *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. Usually high performance computing is not being associated with music - unless Iannis Xenakis' stochastic music which originated from his concern with architecture, such as the xxx Pavillion at Bruxelles World Fair, 19xx

- 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.

Symbolic *versus* technological recording of sound

- "trace" ancient sound recording = identifying the vibrational groove; signal recording, not symbolic notation

- music, in cultural tradition, recorded symbolically; the recording of the acoustic event (signal) succeeded with Thomas Alva Edisons's Phonograph. But in digital sound processing, the symbolical returns: but on a dynamical, time-based level, thus essentially close to the nature of sonic events themselves (which evolve only in time)

"Sound" ecology

- BBC World Service launched the "Save our Sounds" project, looking to "archivize" unique sounds (different from reproducable records) that may soon be lost. It is a sound compressing and filing algorithm which rules the process of sound provenience to permanent storage

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

- iPhone ownern can make use of the free application AdioBoo to record and upload sound; tagging these sonic articulations with "BBC_SOS" feeds it immediately to the interactive map administrator.[128]

- the pre-emptive archive: That bias (cultural recording projects under the temporal perspective of "future in the past") has been 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 on the phonographic inspiration of Kahn's project: Archives de la Parole, foundet by the linguist Ferdinand Brunot in 1911 at Sorbonne university in Paris

- current SOS acoustic memory project personalized in the "Desparately seeking Sounds" report which looks for acoustic childhood memories (covering cow bells, the sound of sky larks, etc.); like sonic equivalents to Marcel Proust's Madeleine as acoustic souvenir, but more specific media-archaeologically as well: recordings of 56k modems, dot-matrix printers and floppy disk drives; Steve Reich, *Different Trains*. Fact is, that for thousands of years sound has been lost already, before the advent of the Edison cylinder: d`Isle-Adam, *L'Éve future*

Sonic arts / acoustic archaeology

- listening to "ancient" recording, in fact from an Edison wax cylinder; now the question, as once expressed by Michel Foucault in a slightly different context: "Message or bruit?"

- 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: spectrogram of reconstructed recording (Wedda chant, Ceylon 1907) on the SpuBiTo web page

This is an analytic, media-archaeological deciphering.

- the "media-archaeological ear", as an alternative to the cultural emphasis on musical semantics. The "sonic" is an area which needs to be media-theoretically developed

- installation *The Physical Value of Sound* by Yuri Suzuki <www.yurisuzuki.com> at the media arts festival Ars Electronica in Linz, September 2009 was explicitely based on the electro-mechanics of (manipulating) records (their

128 See www.bbc.com, and http:/www.pocket-lint.com/news/news.phtml; access 17th June 2009, heading "BBC World Service: 'Save Our Sounds' project". See as well Matthew Humphries, "BBC launches Save our Sounds project" from Jun. 16, 2009: http://www.geek.com/articles/news/bbc-launches ...; accessed 17 June 2009

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[129], 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.

- media archaeologist, without passion, does not hallucinate life when he listens to recorded voices; to media-archaeological observation, 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

SONIFICATION OF MEMORY

The sound of time

- composer Albert Mayr calls himself "time designer", based on a mainly analogue studio for sound art and installations. His main feature is composing with silence, like already John Cage with his famous piece for piano (non-)playing "4'33". Empty endurance ("leere Dauer") is a Bergsonean time which passes. While an empty space within a painting positively endures with time, silence in acoustics is always a (negative) event itself.

Kurenniemi-as-archive: Resistance against the biographical impulse

- listen to what Kurenniemi's synthesizers actually sounds like, preserving the articulation of the medium as memory worth of tradition - witnessing technology

- Articulations of living beings thus become either analog signals (physically) or *symbolically* (digitally) sampled data and thus transformed by technology. The very act of sampling (analog-to-digital conversion) is the essential archival act already, previpous to all subsequent classifications. "Live" - which is the term for time-continuous processes - thus turns into time-discrete models (mapping live onto the archive). Literally, Kurenniemi now becomes digitally *im-mediate*.

Michael Murtaugh and Nicolas Malevé are creating an online archive based on the electronic "life archive" of the electronics developer, music composer, computer expert, filmmaker, and techno-visionary Erkki Kurenniemi. But the relational vector between author and work(s) shifts from composer to the composed, from engineer to the electronic artefact, from author to computer program.

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129 See Karl Sierek, Die weiße Leinwand, in: same author, Aus der Bildhaft. Filmanalyse als Kinoästhetik, Vienna (Sonderzuahl) 1993, 115-130 (122), referring to: Umberto Eco, Semiotik, xxx, 263f

"We have no quantum computer to make sense of its all" <Constant: E. K. (In 2048)> - but there is the analog computer paradigm as differential mathematical modeling and real-time simulation (in fact the first computer Kurenniemi has been confronted with in his own career in a Nuclear Physics laboratory). The virtue of the analog computer has been two-fold which is of relevance to the conceptual Kurenniemi archive: parallel signal processing, and simulation in real-time

- http://www.constantvzw.org/site/Online-Archive-Erkki-Kurenniemi-In.html

- Kurenniemi's private archive currently pre-deposited at the art archives of the Finnish National Gallery, to be catalogued and digitized. Kurenniemi's films and the Dimi-S instrument today are being kept in the collection of the Finish National Gallery,

- some other 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 traditionally use textual documents rather than technological artifacts in their archival reconstructions of the past[130]; 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 the switched-off TV set can be a "historical" (museum) object

- media-archaeological challenge from late Friedrich Kittler's self-constructed synthesizer from the early 1980s. When a techical device from the past is functionally operative, its "historicity" is of a different media-archaeological kind

- For media-archaeological preservation of the DIMI devices, one option is to create a "library" of tonal grains and samples from the original instruments, after digitally sampling their sonic articulations (instead of simply emulating them)

- Thomas Wilfred's visual music named *lumina* and his color organs *Clavilux*, played by keyboard. Wilfred (like Kurenniemi: musician, composer, engineer, inventor) has explicitely stated his objections to recording Lumia works on film

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130 See 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)

(in his writings collected in *Thomas Wilfred's Clavilux*)[131], 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[132]; "ekstant"

- written records, once deciphered, become re-activated by reading them literally (and subsequently transforming them into historiography); a techno-logical artefact needs 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

- Kurenniemi's musico-mathematical theory correlates with the digital circuits devised by him for his earlier electroacoustic instruments. Kurenniemi not only constructs electronic music instruments but reminds of the musicality in techno/logy - both materially (*techné*) and *logically*. He defines music mathematically (thus, rather archaeologically than aesthetically), in his article "Harmonioiden teoria" (= Theory of Harmonies) 1985, and "Musical harmonies are divisor sets"[133]

- Is there a temporal dimension within? Since pitch is nothing but a cognitive metaphor for frequencies, the tone itself is identified as a periodic time event. Karlheinz Stockhausen in his 1956 essay "... wie die Zeit vergeht" described the chromatic tempo-scale, "starting from the oberservation that pitch may be understood as the microtime equivalent of rhythm"[134]

- 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.

I. Wyschnegradsky, in *La loi de la pansonrité* (1953), identified the frequency of a sound ("le son musical du point de vue acoustique") as rhythmic phenomenon, in fact: as sequence of impulses <p. 314>. This interpretation results in a pan-son(or)ic tempr(e)ality of space[135]; inbetween: Karlheinz Stockhausen

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131 Borgo Press 2006

132 Entry Thomas Wilfred in the online encyclopedia *Wikipedia*; http://en.wikipedia.org (accessed April 2013; last modified 23 March 2013)

133 In: M. Karjalainen, T. Lahti, H. Linjama, eds., Proc. of Nordic acoustical meeting 88, Tempere 1988, 371-374

134 Jerome Kohl, The Evolution of Macro- and Micro-Time Relations in Stockhausen's Recent Music, in: Perspectives of New Music147-185 (148)

135 See Barbara Barthelmes, Raum und Klang. Das musikalische und theoretische Schaffen Ivan Wyschnegradskys, Hofheim (Wolke) 1995, 68

- Kurenniemi's artistic work genuinely theory-based already; apply the "Y" model. Both academic media theory and media-artistic "research art" take a parallel root in the technological pre-conditions themselves (the media apparatus, *dispositif*, *archive)*, from which one branch arises which is the artistic (aesthetic) research and another branch is its academic, epistempological analysis. Both branches articulate themselves in parallel ways; model of "communicating tubes": resonate with them.

- Erkki Huhtamo insists that "the development of new technology should not be left in the hands of hardcore technocrats <...>. Artists and idiosyncratic techno-thinkers (and tinkerers) like Kurenniemi have an important contribution to make: pointing out that 'things technological' are never quite as prosaic, predictable and one-dimensional as they may seem" <Huhtamo 2003>. In analogy, academic (media-archaeological) analysis point out the technological things have epistemological implicit value that deserves to be expressed.

"The evolution of Kurenniemi's instrument designs may be regarded as a logical and gradual transition from analog to 'quasi-digital' to digital electronics" <Ojanen et al. 2007: 93>.

- Kurenniemi's instrument designs may be regarded as such a transition from analog to digital electronics; Kurenniemi himself turns out as a processing agency of current techno-poetical discourses of his epoque, rather than a context-independent, auto(r)-poetical romantic subject. Still the individuality of Kurenniemi's works needs an explanation which can not be reduced to a function of its electronics. It is biographical contingencies, anecdotes and dramas which build up to the forces driving research energies (even if the actual research itself is part of academic rules). Such forces are individual idiosyncracies to be presered in Kurenniemi's "life archive".

- Hermeneutics looks 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. In the case of Kurenniemi, he defined this *archive* (articulated in Foucault's sense) himself, by changing the rules, that is: creating his own electronic circuits (and in equivalence his own mathemacial theory of musical harmonics-in-time). This is part of a textuality which can not be expressed by historiography and narrative but rather by the *diagrammatic archive*.

- "Archives, Media and Diagrammatics of Memory"

- Kurenniemi does not perform in a media theater; he *is* media theatre himself: the scene of media. Kurenniemi is not just subject to Latourean non-human agencies, but a protagonist himself, driven by impulses which are in the best sense ideosyncratic, thus: an-archival - the contingent in conflict with the archive. In order to describe that, historiography is not fitting; what is required is rather archaeo-graphy.

- his 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)>

- With Deleuze, technical diagrams rather practice dataveillance than panoptical traditional archive surveillance

Kurenniemi's life can be identified as performative medium scene of techno-aesthetic knowledge. "Intermediaries function as detectors of relationships. Algorithm in dialog with the law" = E. K. (In 2048)

How does one become archive?

Kurenniemi's obsessive self-recording (starting with his tape and video diaries has been meant to be orchestrated in a "re-run of his life"[136] on July 10, 2048, on occasion of his 107th anniversary. But the real archive of a "techno-visionary" (Huhtamo) such as Kurenniemi is to concentrate on his electronic devices which are not body-related but mind-related embodiments of his thoughts - diagrammatic in both operative (hard wiring) and archival forms.

- challenge not just a museological one: how to "archive" Erkki Kurenniemi's electro-acoustic synthesizer machines within classical memory institutions. Let us rather shift the focus of what is considered an archive: Kurenniemi's synthesizer *are* archives themselves already. Let us thus concentrate on 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. Let us thus record (and sample) how Kurenniemi's synthesizers actually sound like, preserving the articulation of the medium as sonic memory worth of tradition - in fact, the technological witness (just like the recordings of the Silbermann organ at Freiberg cathedral in times of the GDR state record label ETERNA preserve how the organ sounded in the 1980s).

The term "operative diagrammatics" refers to the specific media-archaeological way of understanding techno-logical objects as materiality and algorithms in action. The diagram, once understood in a very technical sense, is "information patterns, circuits and relations which give an idea of how the otherwise so complex machines work"[137]; that is exactly what Kurenniemi's film *Electronics in the World of Tomorrow* shows.

- concept of operative diagrammatics relies heavily on regarding our technical apparatuses through the approach of an engineer - a specialist in the

136 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

137 Jussi Parikka, Operative Media Archaeology: Wolfgang Ernst’s Materialist Media Diagrammatics. Theory, Culture & Society, vol. 28, no. 5 (2011), 52-74 (62)

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."[138] 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.[139]

- diagram is not simply something inserted into the machine, but it is what truly generates it through its operation.[140] "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)."

It is this diagram which deserves and demands the archive.

Maybe the encounter between human and machine is "the central drama of our life" (Myron Krueger). Even after life this drama continues, with reverse temporal operators. Human memory becomes machine itself - the driving idea of Kurenniemi's archival obsession.

- Kurenniemi's cybernetic obsession with automation (electronic studio at Helsinki, his development of robots); therefore focus not only on the archival but as well his machinic memory (media memory incorporation) = his electronic artefacts

- "Soviet Digital Electronics Museum" can be addressed under the URL http://www.leningrad.su/museum. The technology of the Soviet Union thus survives both in its material museum artefacts, as well as on the logical level as domain name in the Internet

- not simply turn Kurenniemi's live into a "multimedia database" (Huhtamo), transforming into a virtual databody, but remember his hardware embodiments as well.

"With the aid of an approporate artifical intelligence algorithm yet to be invented, Kurenniemi hopes he will be resurrected as a virtual clone some time in the future" (Huhtamo) - reverse engineering", as encacted in Lynn Herhmann-Leeson's film *Conceiving Ada*

Kurenniemi's memory and after-live is already implemented in the wiring, diagrams and programs of his electroacoustic instruments.

Each time a sonic articulation is re-created by a DIMI synthesizer, Kurenniemi is alive, due to the special power of "re-presencing" (Vivian Sobchack) which belongs to sonic articulation.

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138 Parikka, 2011b, p. 65

139 Parikka, 2011b, p. 65

140 Parikka, 2011b, p. 66

- retro-activate Dimi-0 (1971) which is based on an optical interface, the original pourpose of which was to read sheet music graphically" <Wikipedia> 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*,

Dimi-O can also used in tandem with a dancer whose movements are simultaneoulsly transformed into music.

Such instruments are 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.

- Erkki Kurenniemi's Film *Electronics in the World of Tomorrow* [141]
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)

Kurenniemi's electro-acoustic devices demand almost engineering skills from the musician operating them. Being 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"[142]. Here, the techno-archive is *opened for access*.

Kurenniemi's electronic instruments reflect the technical functionality "at the hardware level" <Ojanen et al. 2007: 92> which is the media-archaeological layer indeed, with the input mechanism being mainly the 'plug in' interface

- close to electronic analog computers as "twins" of electronic synthesizers, and even closer to algorithmic user interfaces like MaxMSP or Pure Data today

- Kurenniemi's austere resistance to apply conventional control interfaces like a keyboard rather favours the pure doctrine of electronic synthesizer access. This expresses the discontinuity which takes place in conventional vs. electronic music instruments instead of hiding it in the sense of Marshall McLuhan's

141 http://ubuweb.com/film/kur.html;
http://www.ubuweb.com/film/kur_electronics.html

142 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

diagnosis that the content of a new medium is always the previous medium. Kurenniemi "did not choose to use a concentional musical instrument user interface (e. g. a keyboard) even in his later innovations where he had clearly put some thought upon the user interface design and usability" <Ojanen et al. 2007: 92>, thus: resisting the temptation to interfacial metaphors

- electro-mechanical Fender Rhodes Piano has been originally developed by Harold Rhodes as a transportable substitute piano, the substitutional electro-mechanism with all its deficiencies compared to the sound of the fully acoustic piano led to 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. Bill Evans used a Fender Rhodes Electric Piano within his ensemble of traditional instrumentation as a supplementary device: "No electric instrument can begin to compare with the quality and resources of a good acoustic instrument."[143]

Although in the age of Digital Signal Processing and Physical Modeling of acoustic instruments by digital simulation this option might be debatable, there is a (probably involuntary) epistemological truth expressed here. Any "e"-instrument electro-magnetically transsubstantiates (to make use of a 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, November 2012>.

- DIMI-T brain wave sonficator: a one page photocopy of Kurennie's draft design (and minimal circuit) for that device. The *a priori* of such fabrications is electrophysiology; "cat microphone"; based upon signal processing, *not* the symbolical order

Digitality embodied within the analog synthesizer

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143 Quoted after: Keith Shadwick, Bill Evans. Everything happens to me. A musical biography, San Francisco, CA et al. (Backbeat Books), 150. See the entry "Fender Rhodes" in the online encyclopedia Wikipedia, accessed August 11, 2013

- Kurenniemi's *Integrated Synthesizer* (developed 1964-1967) "bore a closer resemblance to the 1950s' digital RCA synthesizer than to the voltage-controlled synthesizers of Robert Moog" <Wikipedia>, culimating in his series of Digital Music Instrument (DIMI) synthesizers; digital design based on circuits to determine the pitch of the synthesised sound <Wkipedia> - a diagrammatic design indeed, installing digital memories in music instruments

- human ear already the most immediate analog-to-digital device, converting analog sound signals into discrete nerve impulses in coded time pattern recognition (phase locking).[144]

- As symbolic code in the binary alphabet, numerical data files continue the symbolic 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, therefore 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.

- 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; see 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-

144 See Jürgen Hellbrück / Wolfgang Ellermeier, Hören. Physiologie, Psychologie und Pathologie, Göttingen (Hogrefe), 2. erw. und verbesserte Aufl. 2004, 118f

archaeologically, with hardware close to the process, oriented at its performative essence.[145]

- With electro-acoustically generated signals, the re-animation of a "dormant" (German: "still-liegenden") modular synthesizer is at stake - 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[146]

CO-ORIGINAL MUSIC (RE-)PRODUCTION: THE PLAYER PIANO

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.

While piano play is still a artistic technique, with the *Pianola* automaton it turns into media art: "Kunsttechnik wird zur Technikkunst."[147]

- advertising prospectus from 1905: Welte company differentiates "mechanical music" from its personalized recording technique for reproduction piano "mit allen Feinheiten des rhythmischen und dynamischen Vortrags mit völligem

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145 *apparatus operandi* was presented in a panel at Transmediale 2013, February 2nd, 2013, Haus der Kulturen der Welt, Berlin

146 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*

147 Arno Reinfrank, from his poem on the *Pionala*, in: Bilder einer schrägen Welt. Poesie der Fakten 9, Rohrbach (Peter Guhl) 1996

Erfassen der persönlichen Note"[148]

Compared with contemporary human pianist re-enacting "historic" scores, the reverse question is: Does machinic "interpretation" preserve a different memory, the dynamics of the machine-body?

- 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.[149]

The Welte-Mignon is 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."[150]

The Welte-Mignon is 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 "read" 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 oscillates 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)]

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148 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)

149 See Gottschewski 1996: 26 ff.

150 Daniel N. Stern, The Present Moment in Psychotherapy, New York / London (Norton) 2004, 67, referring to Benhôte, 1972

This 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 preferred performing 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 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.[151]

"The two utilizations of electronic transmission - radio and television "live" broadcast, and its recording for future re-examination and "archival replay" - have been "antidotal" indeed = 350. Inbetween is the timeless studio record editing; "the inclination of electronic media is to extract their content rom historic date" = 342. "Here date is an elusive factor" = 342

Punched piano rolls and the "digital"

- museums of musical instruments aim at the re-enactment of such automata, thereby becoming media-epistemic laboratories (in Freiburg, Bruchsal or Seewen); arises the question of authenticity of re-play

[Musicology at Hochschule der Künste in Bern (HKB), research project (2010/2011) "Recording the Sould 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 allows for the conversion of such data into MIDI files and / or

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151 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)

archiving them as raw data, inducing new options of algorithmic reserach into historical interpretation such as micro-timing

- non-invasive replay allows for separating the archival (authentic) materiality of Welte rolls from its binary information

- Welte-Mignon system allows for 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 have been "digital" recording *avant la lettre*; more exactly it is an analog / digital hybrid. Not simply archival documents, they media-archaeologically remind, in a crude anticipation, of contemporary practice of digital recording as information. Within contemporary sound carrier culture, the Welte-Mignon system recurs.

Piano (re-)play: a cybernetic approach

- with Welte-Mignon encoding, "historically-informed performance" becomes 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"[152], 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, performative) parameter of re-enacting the past, which only symbolically refers to time - while in signal analysis, the time objects actually happen.

- Norwegean composer Blom produced a record which "used chance operations and computer algorithms to write the music, then it is performed by a physical

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152 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

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."[153]

- analog/digital difference between punched card mechanical notation (discrete, "digital") vs. continuous time-varying recording (wave form).

- few options nowadays of catching the authentic "muscial gesture" before the age of technical recording media, the phonograph, and cinematography. Beyond the limits of scriptural sources, the historical performance practice (for dance, theatre and music) relies on "experimental archaeology", indirectly by re-enacting ancient hardware from music museum instruments.[154] The Welte-Mignon recording piano does it automatically.

- 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[155]

Musical score vs. graphical signal and its synthesis in digital signal processing

- diagrammatical understanding of music; "structural listening can take place in the mind through intelligent score-reading, without the physical presence of an external sound source". In Adorno's concept, "the silent, imaginative reading of music could render actual playing as superfluous as speaking is made by reading of written material"[156]

- Welte-Mignon reproduction pianos "read" punched information from rolls, pneumatically triggering piano keys. Is the human musicologist or piano player, when reading 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[157] - implicitely "musical" algorithms in Ada Lovelaces sense .

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153 E-mail communication Blom, January 2017

154 See http://www.sim.spk-berlin.de/aus_dem_depot_1667.html

155 See Shintaro Miyazaki, *algorithmisiert*, 2012

156 Rose Rosengard Subotnik, Deconstructive Variations. Music and Reason in Western Society, Minneapolis (Univ. of Minnesota Press) 1996, chap. 3 ("Toward a Deconstruction of Structual Listening. A Critique of Schoenberg, Adorno, and Stravinsky"), 148-176 (161 f.)

- 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)

Transcribing machine music

- 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. For Nancarrow, the Player Piano is no "dead medium" which has been displaced by phonographic signal-recording; in a different sense of sonic media archaeology, he re-activated the 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", two female pianists, in kind of *reverse media archaeology,* have "humanised" 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, the national broadcasting company asked me to do something on Griegs recordings and make a new work. What I did was to take the midi file that Chase provided and make a music where Griegs 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 (my wife). 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"; response: records listened to on a player in the Media Archaeological Fundus; a moment of cognitive confusion on which parts are "human" and which are "machine" until I realized that apparently the two records had been placed in reverse cover, and in addition, 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 (which I intuively did). I think that (maybe unintentionally) adds to your compositional idea. A further media-epistemological twist came to my mind when I discovered the CD version of Bring Me that Horizon, transferred to the experimental setting of Lyriske Stykken: It makes all the difference if the "mechanical", computer-generated version (side B) is played from vinyl which makes is analog signals; from CD, on

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157 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)

the other hand, the side A version (human pianist) would be digital signals nevertheless" = e-mail Blom, January 20, 2017

PATCH VS KEY-BOARD

Fingers, numbers, MIDI notes: "digital music"

- phonetic writing made spoken language once phonetically "analysibable" (Aristotle / McLuhan), therefore symbolical = machinic (Lacan / Kittler)

- difference between score typewriter (item in 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

- sound, suspended from musical semantics

- 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* resemble 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 dissimulates the sound-processing medium technology.

- Don Buchla's modular electronic synthesizer system *without* key-board[158] (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. Is the player at that moment of contact as well being played by the instrument?

- With the input device of the keyboard, even the "analog synthesizer" has always, media-phenomenologically, been 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.

- ongoing discussion whether the keyboard is integral or (in the Kantean / Derridean sense) *parergonal* (supplementary) to the electronic synthesizer

- 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. the "pure gospel" of analog, "immediate" control; truly "voltage controlled" Analog Computer vs. Digital Computer

- direct circuit control really closer to the electronic device, corresponding with a truly media-archaeological aesthetics of techno-logical (pitch control / coding) immediacy and transitivity?

- Pinch / Tocco differentiate 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 the different modules on a synthesizer. <...> Buchla felt that his separation of signal from control voltages made more sense electronically"[159]

- towards a truly medium-specific aesthetics; message of the medium electronic synthesizer (in terms of McLuhan) is 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)

- even if term "keyboard" just names a discrete input device which is strictly

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158 See Trevor Pinch / Frank Trocco, Shaping the Synthesizer, in: The Sound Studies Reader, ed. Jonathan Sterne, New York (Routledge) 2012, 254-264 (257 f.)

159 Trevor Pinch / Frank Tocco, Analog days. The invention and impact of the Moog synthesizer, Cambridge, Mass. / London (Harvard UP) 2002, 45

peripheral to the (analog) electronic synthesizer, in popular culture it has become a synonym (in rhetorical figures: inbetween a "metonymy" respectively "synekdoche") for an electronic music entertainment machine with automated rhythms and melodies in storage - "aber sie haben nichts mit einem Synthesizer zu tun"[160]

- in music automata, sound emanated 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 we experience the 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 <see Pinch / Tocco 2002: 60ff>; both the Ondes Martenot and the Trautonium used ribbon control to produce continuous changes in pitch <see Pinch / Tocco 2002: 337, note 6>;

- esp. Pitch Wheel as special supplement for intuitive / continuous pitch bending and vibrato; more extreme: Lev Theremin's *Terpsiton*

- 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 lies 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 demand 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"[161]; techno-archive is *opened for access*

- Kurenniemi's electronic instruments reflect the technical functionality "at the

160 Anwandler 2000: 163

161 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

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 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. This expresses the discontinuity which takes place in conventional vs. electronic music instruments instead of hiding it in the sense of Marshall McLuhan's diagnosis that the content of a new medium is always the previous medium. Kurenniemi "did not choose to use a concentional musical instrument user interface (e. g. a keyboard) even in his later innovations where he had clearly put some thought upon the user interface design and usability" <Ojanen et al. 2007: 92>, thus: 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.

- Kurenniemi designs 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, November 2012

- human hand losses its supremacy in controlling the surrounding machine world in favor of a multi-sensatory display

Patching with Pure Data and MARSYAS

- Pure Data (Pd) = "a visual programming language developed by Miller Puckette in the 1990s for creating interactive computer music and multimedia works. <...> Pd is very similar in scope and design to Puckette's original Max program, developed while he was at IRCAM, and is to some degree interoperable with Max/MSP, the commercial successor to the Max language. They may be collectively discussed as members of the Patcher[2] family of languages. <...> Pure Data and Max are both examples of dataflow programming languages. In such languages, functions or "objects" are linked or "patched" together in a graphical environment which models the flow of the control and audio. Unlike the original version of Max, however, Pd was always designed to do control-rate and audio processing on the host central processing unit (CPU), rather than offloading the sound synthesis and signal processing to a digital signal processor (DSP) board (such as the Ariel ISPW which was used for Max/FTS). <...> Like Max, Pd has a modular code base of externals or objects which are used as building blocks for programs written in the software. <...> However, Pd is also a programming language. Modular, reusable units of code written natively in Pd, called "patches" or "abstractions", are used as

standalone programs and freely shared among the Pd user community, and no other programming skill is required to use Pd effectively" = http://en.wikipedia.org/wiki/Pure_Data (accessed 10th July 2014)

- Music Analysis Retrieval and SYnthesis for Audio Signals, "written" by George Tzanetakis (gtzan@cs.uvic.ca)

http://opihi.cs.uvic.ca/NormCutAudio/pdf/Marsyas0.2_UserManual.pdf

"<...> blocks can be combined into data flow networks that *can be modified and controlled dynamically while they process data in soft real-time*"; can even be operated by the intuitive hand (as different from the cognitive hand): "Naive users <...> can interact with the system through the use of graphical user interfaces or high level scripts without actually having to compile any code. Marsyas provides a high-level of control at runtime without sacrificing performance. Expert users can create new primitive objects and create more complex applications by writing code and compiling"

"Other influences include <...> data flow simulation software systems such as SimuLink by Matlab <...>."

"The processing of audio signals requires extensive numerical calculations over large amounts of data especially when real-time performance is desired. <...> Computer Music is possibly one of the most successful application areas for the dataflow programming paradigm. The origins of this idea can possibly be traced to *the physical re-wiring (patching) employed for changing sound characteristics in early modular analog synthesizers.* From the pioneering work on unit generators in the Music N family of language to currently popular visual programming environments such as Max/Msp and Pure Data (PD), the idea of patching components to build systems is familiar to most computer music practitioners

- *live coding* / With-Time-Programming

- According to Heidegger, objects and properties are 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"

SONIC MEDIA RE-ENACTMENT

A sonic medium and its epistemic message: the monochord as instrument of knowledge research

- While some archaeologists in a prehistoric bone flute seek its cultural "meaning", archaeo-acoustics focuses on wavelengths and reverberations[162]

- tight alliance between music & mathematics allows for ahistorical immediacy in re-enactment. Pythagoras did not play the monochord for musical enchantment but rather used it for epistemological investigation: sounding as a way of revealing knowledge of harmic numerical ratios.

- Lasus of Hermione probably coined term *mousiké* itself = West 1994: 225; studied the harmonic ratios by striking vessels partly filled with liquid - ephemeral phonography (for visual analysis of slow waves). We are in a position to re-experience the ancient Greek acoustic setting, even if our ears are epistemologically tuned in different ways

- non-historicising, rather operative "quotation" of Pythgoras' experiment with the monochord in the 6th century B.C. possible today. Pulling such a string, humans actually re-enact the techno-physical insight of the relation between integer numbers and harmonic musical intervalls which once led Greek philosophers to muse about the mathematical beauty of cosmic order in general (including the rejected experience and fear of deviation of this aesthetic ideology resulting in the "Pythagorean *komma*", that is: irrational number relations); 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). We are certainly not in the same historical situation like Pythagoras, since the 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: 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

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162 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

the *event* (Ereignis).[163] 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, we share 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

- "re-enactment of the monochord" argument is transitive to vibrational mechanics; becomes intransitive with electro-acoustic wiring as materialized logics; 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

- co-originary non-human dynamic evidence differs from "personal", arbitrary cultural understanding. Pythagoras, since Greek antiquity itself, "is credited with having personally discovered the numerical basis of the concords. He is alleged to have heard them in hammer blows coming from a smithy, and on investigation to have found that the weights of the hammers stood in the ratios 4:4, 3:2, and 2:1. He is then supposed to have reproduced the concords by putting equal strings under tension from a similarly graded set ot weights. It has been pointed out evre since the seventeenth century that neither part of the story is in accord with the laws of physics" <West xxx: 234>

- aesthetics of "harmonic" ratios is based on integer numbers - which is, the tuning of the ancient Greek ears - thus can be re-exprienced exactly from the *difference* to the physical acoustic event. Greeks preferred the musical theory even if it deviated from the physical experience, the actual techno-acoustic event.

Sonic memory's two technological embodiments: physical signal and archival symbol

- in their physical existence, both mechanical and electronic storage devices allow for time-invariant replay of audio signals; increasingly subject to macro-temporal entropy over time such as the material deteriorisation of Edison cylinders or magnetic tapes. "Analogue" sound recording media like

163 See Martin Heidegger, Beiträge zur Philosophie (Vom Ereignis), [= Gesamtausgabe III. Abt. Unveröffentliche Abhandlungen Vorträge - Gedachtes. Bd. 65.], Frankfurt/M. (Klostermann), 3rd edition 2003

phonographic, gramophonic and magnetophonic records are subject to entropic time themselves; they "degrade over time in quality with every copy and in themselves.

"Whenever content moved from one format to another, what is lost or changed and does it matter? / When one copies the content of an Edison cylinder to a CD, is anything important of the content of the subjective listening experience lost?"[164]

- any work of media art grounds in art*efact* (hard- or software) which sometimes reminds itself by malfunction

- sonic media artefacts not only preserve 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 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 "mémoire involontaire", message *and* noise, need to be preserved in media-archival conservation ethics.

When the techniques of audio carriers for cultural memory change from technically extended forms of writing such as analog phonography to calculation (digitization), this is not just another version of the materialities of cultural tradition, but a conceptual change.

Archival endurance (with its records oscillating between symbolic historical and physically entropical time) is undermined when an acoustic record is not fixed any more in a permanent storage medium but takes places electronically; flow (the current) replaces the physical inscription.

Between mechanical and electro-magnetic audio recording, there is 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, points out "the current shift from analogue's sequential waves to

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164 Ray Edmondson (National Film & Sound Archive, Australia), AV archiving philosophy - the technical dimension, in: papers of the IAMI-IASA Joint Anjnual Conference, Perugia 1996, no. 8, November 1996, 28-35 (28f)

digital's recombinant codes" in technology.[165] 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 points out that any such rules of audio preservation need to be revised when changes of the technological conditions take place.[166]

Digital data need 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.

From that moment on, material transfer is 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.

Oversampling phonographic records allows for archiving the noise of the apparatus itself as well.

The *a priori* of the sonic time machine: re-encacting electronic music

- Alexander Bell, experimenting with electric voice transmission, occasionally invented 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.[167]

- 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

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165 Viola 1990: 47

166 See http://www.iasa-web.org/IASA TC03/IASA TC03.pdf (accessed June 2011)

167 http://www.antiquetelephonehistory.com/sciencefork.html; Abruf 23. Juli 2014

(due to the analogy between mechanical and electric "resonant circuit", see Barkhausen, *Schwingungslehre*) is the re-performance of electronic music.

If knowledge of media art is not meant to be limited to illustrations in printed texts and books (the library), to distant static object observation (in museums) and to pure documentation (in archives), there is a need for real places and digital platforms where technical objects can be "hands-on" engaged in their primary materiality and virtual operability.

- emulation of an analog electro-acoustic synthesizer by digital software will always be just a quotation since even digital signal processing and the sampling theoreme remains on the symbolic functional level. The actual technological archive, different from the textual record usually contained in instutitonal archives, consists of material devices - just like in late Friedrich Kittler's "estate", now preserved at the German *Literaturarchiv* (Marbach a. N.), among many papers consists of the modules of his self-engineered electro-acoustic synthesizer as well. The media-artistic relation to the past requires not simply a symbolical quotation but a physical re-enactment.

It makes a whole world of difference between simulating or just emulating a previous computer game console on a contemporary computer platform. Simulation is 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 logis. 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[168] - a playful target for 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

[- just like the electronic image, different from traditional painting, only exists when succeeding within a time-critical window of synchronized presence]

- 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": In its cracks, architecture reveals its entropic destiny[169], 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 enable analytical investigation,

168 A suggestion by Marcus Bastos (Sao Paolo), e-mail communication from September 9, 2016

169 Karl-Eugen Kurrer, Zur Geschichtlichkeit von Bauwerken, in: Stahlbau vol. 70 (2001), no. 9, 159

recreating the same auditive events that the device would have produced when it was first sold. Such re-generated techno-logical sound differs from simply transductive replay such as the pick-up of phonographic records; the device itself allows for a co-originary experience.

The rehearsal of a musical piece from the past transcends its unique location in historical time (Walter Benjamin's "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.[170] 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*"[171]. 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.

The analogy between musical instruments and electronical media is essential: both are "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."[172]

- 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 [...]."[173]

Such a techno-logical sense of time is everything but *metaphysical*; media-

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

171 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

172 Peter Donhauser, Österreichische Pioniere der "Elektrischen Musik" und die Medienarchäologie, in: Gethmann (Hg.) 2010, 73-96 (92)

173 Geoffrey Winthrop-Young, Kittler's Siren Recursions, forthcoming in: xxx; actual URL: xxx

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 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

- archiving of storage media containing music (printed scores, analogue tapes, digital tapes, CDs) relatively easy compared to the preservation of obsolete computer programs and electronic hardware itself, as shown by [...] the exhibition Digital Art Works – The Challenges of Conservation at the ZKM Karlsruhe"[174]

174 Chiara Marchini Camia, Digital Art Works - The Challenges of Conservation, Karlsruhe: ZKM, 2012