["ON TIME-CRITICALITY"]

Electrophysiology
Kinaesthetics of the electronic image (with Viola)
Audiovision with Julian Jaynes and with Bill Viola
Media of audio-vision: Sound film and music video
From silent movies to film sound
... with Chion
From television to sound: *Phonovision* and the *Optophone*
An electronic device for wilful (technological) synesthesia: the Optophone
The neurological basis for synesthesia and its electrophysiological detection
Is there a specific sense of time?

ANALOGUE-TO-DIGITAL MEDIA THEATRE
Algorithmicized media theatre
Theater / machine
"Richard Two Bodies"
Looped performance: Tape-based media theatre (Krapp)
Hatsune Miku "on stage"
Between analog transmission and intelligent coding: "Algorithmic liveness.
Editing the audiovisual present" (Marcus Bastos)

THE (ALGO-)RHYTHMISATION OF CULTURAL VALUE: DYNAMIC MEMORY AND
MUSEAL RESISTANCE
Non-"museal", operative material media archaeology (MAF, Signal Lab)
Cultural tradition / transmission in terms of communication theory
"Cultural value" and the sense of time
Not yet memory? Intermediary storage, delay lines
Resisting acceleration: the *katechontic* function of archives and museums
The new role of the museum (object)
Up-dating "Museums on the Digital Frontier" (Kittler)
Digitally interfacing the museum from within: new options of sorting images
"Digital archi(ve)textures"
"The Virtual Curator: multimedia technologies and the roles of museums"
(Beardon / Worden)

TEMPERATURE DEGREE ZERO: TECHNICAL "COLD" STORAGE
Very Low Frequencies: The temporality of Arctic temperature
Listening to entropy: "On Speed" (Christian Blom)
Chrono-photographic freezing
The "cold gaze": Media archaeology in alliance with the photography

TEMPERATURES OF CULTURAL TRADITION: ENTROPY INSTEAD OF "TIME"
[Data-entropy, energy, information]
[Frozen vibrations]
[Arctic conditions for signal and data storage: the museum case]
Recirculating digital memory: the Delay Line
[Frozen voices: Making the temp*orality* of sonic world-signals symbolically
calculable]
Cooling down media memory: video testimony

TIME MACHINERIES
term "equiprimordiality"
Experiencing media tempor(e)alities

Chrono-technical irritations

TIME-CRITICALITY

Time-critical signal processing in humans and machines

- the time-critical *is* the temporal (in its etymological sense of "cutting, dividing"). "The cinema is the truest time-art of all, since it most closely parallels the operation of time itself" = Gerald Mast, Film / Cinema / Movie, New York (Harper) 1977, 112; critique Bergson

- time-criticality differs from simply time-based processes; video art (Viola) as articulation of "Bergsonean" temporality and materiality

- analysis of time-critical signal processing in systems, that is: both in animals and in machines, reactivating previous cybernetic assumptions under specific perspective of such micro-tempor(e)alities; Wiener's *Cybernetics* of 1948. Signal processing as a topic of applied mathematics - in the neo-cybernetic sense - does not refer to electrical engineering only[1]; time-varying quantities; sonography, electrocardiograms

Time-criticality with McLuhan

- time-critically sharpened reading of McLuhan's medium = message theorem leads to new ways of approaching the temporal bias of technical media which is not only a macro-temporal *bias of communication* in a Harold Innis-mode of media theory, but an intensive microtemporality

- the temporal message of digital communication media is in temporal deferal: from *live on tape* to media content *on demand*. This is the temporal signature of webcasting: "In der Fülle des Angebots und der Möglichkeit der Nutzer, jederzeit darauf zugreifen zu können, liegt der Unterschied zu den klassischen Formen von Hörfunk und Fernsehen."[2] This time-critical souvereignty and immediacy in access means a "tactilization" of consuming what has been non-individual mass media broadcasting before, in fact: an almost *haptic* access to media time (to use one of McLuhan's terms for describing electroic communication). Something disappears at the same time: the clear distinction between what is present and what is past, what is transmitted "live" and what comes out of the archive. Some online-services of radio or TV channels offer

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1 See, for example, J. D. North, Application of Communication Theory to the Human Operator, in: Colin Cherry (Hg.), 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, 372-389

2 Andreas Bade, Radio im Internet. Zwei Wege für die "Stimme" im Netz, in: ders., Das Internet als programmbegleitendes Medium des Hörfunks. Historische Entwicklung von Internet, Radio und ihrer Medientheorien, Hamburg (Diplomica Verlag) 2009, Kapitel 3 (57-86), *online*-Veröffentlichung unter http://www.mediaculture-online.de

access to commentaries on current news, while at the same time offering access to other commentaries on previous occasions. The delineations of the archive to the present become diffuse, almost fuzzy

Time-critical technical memories

- memory *technically* defined as "a device into which information can be introduced and then extracted at a considerably later time" = Glossary, in: Edward B. Magrab / Donald S. Blomquist, The Measurement of Time-Varying Phenomena, New York et al. (Wiley) 1971, 314; close to what is known as a buffer in electronics. Minimal delay memories are at work in time-based and time-critical media even the more if we do not notice them. Drastically, these binary micro-memories dissimulate apparent "live" transmission by calculation in *real time*

Acoustic quanta in poetic prosody

- micro-temporal synchronization of instrumental play (one-string *gusle*) with real-time production of poetic articulation by the singer (*guslar* in Bosnia / Montenegro). Investigations into musical cognition turn (by Leman / Godoy et al.) media-archaeological with focus on the role of the measuring instruments / algorithms applied in identifying such servomotoric / cognitive correlations; computational ethnomusicolgy; media studies concentrate on technological agency and a/synchronicities induced by the *temporal* machine-human coupling

- prosody concerned with the temporal extensions of phono-poetic articulation; Aristoxenos, fragment of his rhythm analysis: temporal (*chronoi*) of prosodic variation = D*t*; See Lionel Pearson, Introduction II: The Greek Theory of Rhythm, in: Aristoxenus, Elementa Rhythmica. The Fragment of Book II and the Additional Evidence for Aristoxenian Rhythmic Theory, Oxford (Clarendon Press) 1990, xxxiii-liii

"Algorhythmics" (Miyazaki) within digital computer and digital communication (mobile telephony): new techno-prosody ("Dactyla")

- ancient Greek prosody based on time units ("acoustic quanta") rather than pitch accentuation; f*requency modulation* in radio technology vs. amplitude modulation : the temporal "Akkordeon", temporal extension and compression

Béla Bartók's transcription of Salih Ugljanin's 1935 rehearsal of *Ropstvo Djuliç Ibrahima*: "Bartók faced the challenge of interpreting rhythmic groupings that had no archival body of traditional (art music) reference" <Foster>. This required a change from symbolic score notation (the "musical" regime) to sound analysis. "Notation <...> is unable to account fully for every tempo variation in art music."

the *sonopoetic* momentum is accessible in its eventality for time-critical analysis only by means of direct electro-magnetic transduction of phonographic records from the Sound Archive

The neuronal time window for song and sound

- human interval for identifying signal events and pulse trains as taking place in the present = three seconds within which they can be integrated and synchronized into a coherent impression[3]

- function of the *gusle* in oral poetry: synchronizing with the metric production of verse lines within the human time-window of the "present"; technologies for uncovering the correlations between oral poetic articulation and senso-motoric instrument feedback

Algorithmic "Tempor(e)alities"

- both "archiving the present" and "re-presencing the archive"; ambivalence of the present / presence; presence-generating media; complex notions of "live" transmission in television; healing prayer through the glass tube: http://forums.ssrc.org/ndsp/2013/04/10/tv-prayer

- algorithmic analysis / "Digital (post-)Humanities"; the techno-trauma becomes a techno-mathematical trauma. Interpreted with Alan Turing, "algorithmic memory" is the most post-human and the most human one at the same time (see his "Imitation Game"); the traumatic effect is rooted in the logic of computative algorithms (and Artifical Intelligence) itself, embracing both man and machine

- memory between archive and re-presencing; "fuzzy presence"

- coupled with human perception, electronic and algorithmic media operations result in specific irritations of the human sense of time; techno-traumatic operations and the reproduction of presence ('representing') through technical media

- *aura* (as defined by Benjamin) depending on being "here and now"; technological temp*aura*lity and specifically its sonic articulations culminate in the archetype of photocentric presence, the voice

PRESENT INSTANTANEITY

Just-in-time criticality

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3 See Alexander Grau, Zeitpunkte, Zeitfenster, Zeiträume. Wie das Gehirn unsere Wahrnehmung organisiert, in: Klaus-Dieter Felsmann (ed.), Der Rezipient im Spannungsfeld von Zeit und Medien, München (kopaed) 2008, 37-44 (41)

- Ilka Becker / Michael Cuntz / Michael Wetzel (eds.), Just Not In Time. Inframedialität und non-lineare Zeitlichkeiten in Kunst, Film, Literatur und Philosophie, München (Fink) 2011

- time-criticality as it relates to the rhythm of logistics, specifically the just-in-time production and distribution = e-mail Atle Kjosen, 16 September 2014; the cultural technique (format) of the schedule (be it of bus timetables, train schedules, port schedules, order picking etc.) a symbolic precursor to time-criticality in digital media. Virilio in *Negative Horizon*: the schedule is the administration of time

- just-in-time production a precursor of what is called "real time" in digital media, different from analog "live" signal transmission

- within operative computing, algorithmic functions like the "interrupt" most crucial in that respect - microtemporal processes; High Frequency Trading at the virtual stock market

- anti-aircraft prediction in World War II as origin of what Norbert Wiener later termed *cybernetics*; just-in-time logics in computing: Is a problem solvable in polynomical time ("finite"); variance of *Halteproblems*, such as sorting algorithms

- so-called "temporal logic" is of intensional nature: formulas are evaluated not in abstract space from outside time (as in classical logic), but temporally local, i. e. at points of time. In propositional temporal logic, propositional elements can be either true or false depending on their point of time; first order temporal logic with "until" and "since"; D. Gabbay et al., Temporal Logic. Mathematical Foundations and Computational Aspects, vol. 1, O. U. P. 1994; H. Kamp, Tense logic and the theory of linear order, Ph.D thesis Univ. of Cal., LA, 1968; same author, Formal properties of "now", in: Theoria vol. 37 (1971), 237-273; Ian Hodkinson, Notes on games in temporal logic, URL

- in gaming, competitors struggle with topological lags in their Internet connections / LAN, and hardware / symbol processing devices (monitors)

- operative computer game analysis "The Physics of Pac-Man" (Stefan Höltgen); game studies in a media-archaeological way, ranging from "Flatland" (Abbott) and "wormholes" until the concrete code and storage address location in the RAM chips: Where is Pac-Man when he vanishes for seconds from the monitor edges?

- difference between the concept and reality of "real-time" as different from "live" (or "immediacy")

Telegraphic immediacy

- Napoleon's network of 224 line-of-sight semaphore stations, spanning over 1,000 miles. "The coded message had to be repeated accurately at each station [...] to get through. [...]" = Schwartz, Resonant Chord 1974: 3; required reinforcement (in the electro-magnetic Siemens telegraph relay sense)

- temporality of machines becomes delicate (time-critical) in terms of delays; while crisis of stock market in 1980s partly due to traders delaying answering their phone calls, nowadays non-human "calls". As to e-mail delay, the mystery is easy to reveal: living part-time in the "off-line" mode, temporal gap opens between time stamp of message writing at home and actual sending online at office

- physically, apparent immediacy of electromagnetic transmission not real, as identified by Maxwell's mathematical calculation of Newtons instantaneity model for propagation of such waves, and Hertz' experimental proof, which (unplanned) resulted in radio broadcasting

- immediate transmission = phantasmatic desire in early telegraphy, killing space by the effect of contemporary time (Heine); the very term tele*graphy* "re-mediated" the new communication medium to the well-known culture of alphabetic writing. Telegraphy is about sequential coding and decoding, strictly linear. But the electric "writing" of tele-graphy is coding time.

Contemporary Condition(ing) in media culture

- any high-technological device a multi-temporal hybrid; different from the "diachronic" geological or archaeological layers (so-called "deep time"), a co-operativity. Since techno-logical regimes are co-originary, the components co-operate even if they stem from different techno-historical ages. A present automobile, e. g., "is a disparate aggregate of scientific and technical solutions dating from different periods. Once can date it component by component: this part was invented at the turn of the century, another ten years ago, and Carnot's cycle is almost two hundred years old. [...] the wheel dates back to Neolithic times. The ensemble is only contemporary by assemblage."[4] This is a techno-archival defining condition of our "historical present" - historicism, or present-in-the-past?

- "[c]o-historicity" refers to abundance of mediatised and mediated pasts, histories and memories" = Martin Pogačar, Culture of the Past: Digital Connectivity, Co-historicity and Dispotentiated Futures, in: Andrew Hoskins (ed., Digital Memory Studies. Remembering through digital and social media, New York (Routledge)

- time-critical processes where a temporal moment is decisive for the success of the action at all requires programming close to the machine: the microtemporality of the assembly language

- "transmission" has become a metaphor (in its linguistic and technical sense of "transfer") for the contemporary: fast transmissions as devices that accelerate people and society, and gaps / delays in transmission as methods to strive for slower times and processes (Marcus Bastos)

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4 Michel Serres, Conversations on Science, Culture, and Time, Michigan (Univ. of Michigan Press) 1995, as quoted here (as motto) in: Timothy Barker, Re-Composing the Digital Present, in: xxx, 88-103 (89)

- by digitizing archival records for present addressing *online*, the archive which formerly served as an enduring secluded "off-line" memory of legal claims, now changes to operative storage, techno-mathematically integrating past data to present consumption

- notion of the contemporary oscillates between the micro-politics of human subjectivity and machine time; being "radically present in the world now" = Aarhus project draft): *radix* (as mathematical operator, the square root) itself is a hint; the present is always already rooted in micro-temporal retentions (intermediary storage, as technologically active in early acoustic delay lines and even air as Delta-*t*), and electro-physically embodied in the accumulator for current power supply as condition for media mobility: ephemeral "storage" instead of permanent coupling to the grid, corresponding with the temporariness of mobile commbunication

- human "echo" experience analyses the aural presence of the immediate past and the schizophrenic and self-distanced presence; different from that phenomenological experience concept of contemporaneity understood as the coming together of different times in our "historical present", the "vehicle" of this coming together of different times is primarily the media

- in financial high frequency e-trading, emphatic "time" replaced by instantaneity: chrono-options. The figure of High Frequency Trading in the algorithmicized stock market is just the contemporary practice of a time-critical figure derived from techno-cybernetics in Second World War: the challenge of Anti-aircraft prediction, that is: anticipating the trajectories of an enemy plane or ballistic missile in "real time", that is: already in the present; Husserl re-/protention; "flash crashs" in HFT: irruption of temporal exception / faster than time / the traumatic "tempo*real*"

- the "contemporary" already split into "hyper-contemporary", optionalism based on the temporealities in the financial markets[5]; on the back cover of Armen Avanessian / Suhail Malik (eds.), Der Zeitkomplex. Postcontemporary, Berlin (Merve Verlag) 2016: a vertical column expresses the present condition with a double letter in the very beginning, thereby oscillating between the "CONTEMPORARY" and the "NONTEMPORARY". Temporality itself is obliterated, in favor or temporealities

CLOCKING MACHINE TRANSCENDS CULTURAL TIME SENSE

Not to be confused: Media operativity and cultural bias

[= radical modifications of previous thematic modules (transl. into English by Michael Durroch); see W. E., Ticking Clock, Vibrating String: How Time Sense Oscillates Between Religion and Machine, in: Jeremy Stolow (ed.), Deus In Machina: Religion, Technology, and the Things in Between, New York (Fordham University Press) 2013, 43-60]

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5 Elena Esposito, Die Konstruktion von Unberechenbarkeit, in: Avanessian / Malik (eds.) 2016, 37-42

- wheeled clock with mechanical escapement as opposed to simply mechanical clock; "to clock" or "to synchronise": beating, pulsing, oscillating

- investigate relation between media and religion not on the discursive, but on the technological level - the regime or hardware, media-epistemologically, technologies are indifferent to the question whether they have been installed out of a religious bias or not, even if they bear the imprint of this bias in technical form (just like the von-Neumann architecture of the programmable computer we use today still carries the genealogy of its original context: to create a machine which could calculate the triggering mechanism of the Hydrogene bomb, Los Alamos)

- media-archaeological revision of cultural history; relations between relgion and technology de-coupled by wheeled clock mechanism; not confuse religious practices with technological terms (association between liturgy and algorithm); what differentiates cultural techniques from genuine media technologies, insisting on the non-cultural element in technical media; cultural metaphors obscure media practice. Original divergence / non-"path dependency": oscillating clock resulting from late medieval monasteries; epistemological dis/continuity from religious timing to time-based media processes, resulting in differential oscillations (Leibniz et al.) which separate Pythagorean cosmology from electro-technical media age; mechanical clock "beat" stems from monastic Benedictine culture, but later emancipates knowledge from cosmic-religious time (heaven); Oresme's essay on planetary moves ("ciel")

- decisive mechanism defining the "truly mechanical clock" = North 1975: 392 from traditional astronomical mechanisms is verge or foliot escapement (such as Giovanni de´Dondi clock); later replaced by the pendulum. Periods of swing (oscillations) once restricted to observation of planetary systems for agricultural use, when mastered by mechanic knowledge, becomes fundamental parameter for micro-temporal events, opening media-operative measuring devices insight into a world of time-critical operations unknown to human perception (*aisthesis* / aesthetics) before. Media archeology not interested in ways in which oscillatory mechanism for both measuring time and striking a bell in the thirteenth century "was obsorbed into the high ritual of the church" = North 1975: 393; canonical hours of the monastic life - especially in the Cisterian rule where Rule XCIV asks for *horologium temperare* and *facere sonare* - almost inevitably / non-disursively induced "automatic control" = North 1975: 382 f.; desire to cause a clock to sound on its own, operates on a level which is closer to science than to religion. Parallel to cultural *logos*, techno-logical reasoning at work; media archaeology uncovers that below the apparent cultural use a different kind of "epistemic thing" (Rheinberger) was established on a level sub-conscious to culture and religion: a training of sensibility to micro-temporal events. While the essence of "time" had been a favourite topic of analysis in early Greek philosophy and musicology, its media-technological reproduction by oscillaltory mechanisms follows a logics of its own

- religion is cultural engineering; technological media are basically, but not completely indifferent to their religious or non-religious use; whether religious rituals could already be called mediatic performances or should rather be

categorized under "cultural technologies" (in decisive difference to genuine media opperations)

- technologies, once in operation, become indifferent to whatever has been its cultural or discursive bias in their implementation, even if this bias has left an imprint in their technical form? Is there any correlation between procedural forms such as liturgy and algorithm? What differentiates the general cultural engineering of symbolic, even transcendental systems, such as religion, from genuine media technologies, namely, those based on the laws of physics or mathematics? Is there a noncultural, autopoietic element at work in technical media that escapes discursive (social) relativity?

- epistemological discontinuity: separating religious timing from technical processes based on equi-temporal (periodic) oscillations (Huygens)

- poetic oral articulation in distinct syllables / a temporal sense of measurable prosodic "beats"; only in the context of the medieval Christian European monastery that the cultural engineering of timing processes began to be implemented technologically. Monastic prayer routines and working practices according to the Benedictine rule were closely tied to a sense of periodic beats; not just cycles of the day or year (which vary in their duration) but also the prosody of liturgical chants or the rhythm of the gestures of work. Rolf Nohr states that "With the division of the day into distinct parts, each one fixed within an ordered framework of work and prayer, the order of monastic life became conceivably one of the points on which the framework of the rhythmic was established" = Rolf F. Nohr, Rhythmusarbeit, in: Britta Neitzel / Rolf F. Nohr (eds.), Das Spiel mit dem Medium, Marburg (Schüren, 2006), 225 (translation Michael Darroch); development of such mechanisms had the paradoxical effect of emancipating Occidental culture from its dependency on cosmic religious time. The attunement to periodic beats precipitated a decidedly nonreligious development, based on the growing knowledge and familiarity with oscillating mechanisms present in vibrating strings; same awareness led to the notion of "frequency" developed by modern acoustics and other forms of wave analysis, culminating most recently in the development of modern electronic media and in the timing mechanisms of computers. Deconstruction is technologically at work here; the escapement mechanism of the ticking, cogwheeled clock was a direct outgrowth of monastic rhythms, but that very technological development ultimately became a provocation to the liturgical world. Once the framework of monastic rhythms transferred to technological order of the ticking clock, bells no longer tolled for traditional cosmic time

- time as existential category to which religion and technologies have been giving decisively different answers; double-edged approach to modern techno-scientific practice as function of instrumental designs and functional properties of specific technologies, its specific mechanical and mathematical capacities to compress or accelerate time, or to erase distance and reproduce sameness: features developed in differentiation from ritualistic experiences of time. Tracing phenomenologically imperceptible natural events rather than symbolically ordered time, media separate themselves from religion, just as the oscillating clock grew out of, then away from, the medieval monastery. Even if philosophers such as Newton and Leibniz, while applying the mathematical approach to the physical world, they also grounded themselves in firm

metaphysical / religious beliefs concerning the order of the world, their techno-mathematical work autopoietically developed into a techno-mathematized world of its own

- traditional cultural categories of time challenged by current sampling techniques (e.g., digital signal processing) or by artificially setting a time base. What used to be mutually determinative relationship between religion and technology, turns into extremely divergent cultures of practicing time

Vibrating sense of time: between liturgy and machine

- "There is clocklessness, for sure, but no such thing as 'timelessness'"[6]

- "time does not mean watches, clocks or the oscillations of caesium atoms, time is not found in digital pips or paper calendars, time is not in pendulums or in chronometers; the clock is not a synonym for time but the opposite of time. The West's obsessive time measurement has gone hypertelic" = Griffith 12; Bergsonean argument

- cultural history discovers tight relations between religion and technology, with a seductive force to reformulate religious practices in technological terms = concept "cultural techniques" vs. non-cultural, techno-poetical element at work which is being focused upon by the close analysis of the Anchor escapement mechanism of the oscillating clock. While originating from the late medieval monasteries, its technical logic resulted in time-based media processes which challenge historical narrative itself

- media-archaeological event level (analogous to Braudel's tri-fold paces of time / *durée*) = the regime of non-discursive technologies with an inherent logics of its own; technologies - once they are operative - indifferent to the question whether they have been installed out of a religious bias or not, even if they bear the imprint of this bias in technical form

- instead of reformulating religious practices in technological terms (association between liturgy and algorithm), precisely ask what differentiates cultural techniques from genuine media technologies, insisting on the non-cultural element in technologies (their inherent auto-poietical logics); epistemological dis/continuity from religious timing to time-based media processes, resulting in an awareness of differential oscillations (Huygens, Mersenne, Leibniz et al.) which separate the Pythagorean cosmology from the electro-technical and techno-mathematical media age

- "Lewis Mumford has suggested that the clock preceded the printing press in order of influence on the mechanization of society. But Mumford takes no account of the phonetic alphabet as the technology that had made possible the visual and uniform fragmentation of time" = McLuhan xxx: 147; ancient Greek interest in *cosmos* triggered insight into the relation between harmony and mathematics; phonetic alphabet gave a training in analytical thought (McLuhan); a sense of "beat" stems from the analytic discretisation of

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6 Jay Griffith, Pip Pip. A Sideways Look at Time, London (Flamingo) 1999, 267

articulations as first pactices by the phonetic alphabet but led to its automated implementation on by need of religious monastic culture. Against Christian teleological sense of temporal linearity (later replaced by "arrow of time" inscribed by the 2nd law of thermodynamics into physical processes), transcendent time became *timing* once implemented in *operative* media

- phonetic alphabet rather corresponds with mechanical cinematics in its technical meaning, like the clock-work of timing relates to the mathematical position system of numbers: "Just as a great revolution in mathematics came when positional, tandem numbers were discovered (302 instead of 32, and so on), so great cultural changes occured in the West when it was found possible to fix time as something that happens between two points" = McLuhan 1964, chap. 15: "Clocks. The Scent of Time", 145-146 (145)

"As a piece of technology, the clock is a machine that produces uniform seconds, minutes, and hours on an assembly-line pattern. Processed in this uniform way, time is separated from the rhythms of human experience. The mechanical clock <...> helps to create the image of a numerically quantified and mechanically powered universe" = ibid., 146

- sense of periodic repetition may have been culturally linked to liturgic practice but led to a rather non-religious take-off of oscillating mechanisms, from wheeled clock to "clocking" within electronic computing itself

Ruptures between cultural techniques and media technology

- technological inheritance not historically "past" but endures as inherent archive of techniques and material constellations

- oscillating clock a nonhuman mechanism which conditions the rhythm of human bodies and minds, replacing mythic or religious temporal rituals; escapement mechanism in wheeled clock an epistemogenic artifact which differentiates cultural techniques from genuine media technologies

- literally time-critical criterion which emancipates media culture from traditional cultural symbolism: time measurement breaks loose from natural temporal perception and becomes a matter of the automated setting of time, in a rhythm freed from allegorical interpretations; difference between letterpress and handwriting as an analogy for the transformation enacted by the wheeled clock. As mechanical instruments, both letterpress and wheeled clock possess a central characteristic of technological media: the identical reproduction of elementary units of measurement. In contrast to rituals and liturgy, mechanized time is no longer symbolically performative but rather technically operative; not time per se that is operative here, rather its implementation in a material artifact; Gutenberg's casting process for metal letters resulting in standardization of characters correlating with the wheeled clock in automation of temporal intervals

- Medieval Christian monasteries characterized by a peculiar representation of cyclical time (the liturgical year, the division of days into rhythms of prayer), resulting in need to regulate forms of living into liturgical "algorithms" by

precisely quantified measurements of time in the form of hours of equal length (equinoctial hours); introduction of temporal beats an epistemologically fundamental inheritance of monastic culture, yet resulted in technically mediatized time, afterwards employed to undo cyclical time; mechanical beat became a criterion for literally separating medieval from modern time(s). Time, in this case, both subject and object of a media-archaeological *momentum*

Chronology, Clock, Rhythm vs. Monastic Planning of Time

- significant ancient Greek modification of Phenicean syllabic alphabet into phonetic alphabet by explicitely adding single letters for single vowels. Even if this must have happened at once peculiar instance by an individual creative act (Powell, *Homer and the Origin of Writing*), this still occurred anonymously in the media-archaeological sense. Gerhard Dohrn-van Rossum, History of the Hour, Chicago (University of Chicago Press) 1996: no explicit human intention manifested in the innovation of the "verge-and-foliot" escapement; in this key self-regulating mechanism that directed the motion of the late medieval wheeled clock, rather a techno-logics unfolds itself. In Benedictine monasteries, *a priori* no compelling interest in standardizing time through mechanically reproducible synchronization

- Leibniz may have subconsciously - according to his concept of *pétites perceptions* - had the binary pulsing of the ticking clock in his acoustic mind when he formulated his theological-mathematical dyad as a "wonderful origin of all numbers from 1 and 0, which offers a beautiful model of the mystery of creation, for all things originate from God and otherwise out of nothing: *essentiae rerum sunt sicut numeri* = Letter from Leibniz, 18 May 1696, quoted in Hans J. Zacher, Die Hauptschriften zur Dyadik von G. W. Leibniz. Ein Beitrag zur Geschichte des binären Zahlensystems (Frankfurt/M: Klostermann, 1973), 209

- becoming quasi-mechanical, human bodies disciplined and manipulated on the temporal axis; yielded a microphysics of power in the form of temporal rhythm; synchronized time measurement (as in the coupling of clockwork and photography, e.g., in chronophotography) ultimately facilitated a form of media-technical analysis of movement that would finally produce a re-synthesis, in the form of cinema

- "continuously ticking" (oxymoron) since the second half of the thirteenth century, the wheeled clock, equipped with a verge escapement mechanism that controlled the advancing gear train at regular intervals or "ticks", put into practice a negentropic dissection of the flow of time, analogous to the spatialization of the printing press. In lieu of the constant, analog character of the sundial indicator, the pulse of the mechanical clock was balanced through even intervals of the taut (and thus stored or potential) energy of a weight. As the verge escapement forced time constantly to expend itself, the seeming continuity of time was subdivided into even segments, a folding together of the analog and the digital; an early form of the binary implementation (informatization indeed) of mechanical processes as they had been known ever since mill wheels; regulation based upon an interruption: kind of material embodyment of zero at the temporal level; Peter Gendolla, Die Einrichtung der

Zeit, in: Christian W. Thomsen / Hans Holländer, eds. Augenblick und Zeitpunkt (Darmstadt: Wissenschaftliche Buchgesellschaft, 1984), 49; once zero was calculated as a gap (a condition of the positional notation system), clock ticked at regular intervals

- highly literate communities could imagine accepting the fragmentation of life into minutes and hours = Marshall McLuhan, *Understanding Media. The Extensions of Man* (New York: McGraw Hill, 1964), 142; time came to be conceived as something radically discrete: a virtual differential. However, "it was not until printing extended the visual faculty into very high precision, uniformity, and intensity of special order that the other senses could be restrained or depressed sufficiently to create the new awareness of infinity" = Ibid, 112; accompanied the idea of the research experiment, as well as the "concept of indefinite repetition so necessary to the mathematical concept of infinity," which ultimately culminated in Leibniz and Newton's infinitesimal calculus = ibid, 112

- static aesthetic of order in the concept of the cosmos became a dynamic wheel with a wheeled clock. Nicole d'Oresme preoccupied with the relationship between uniform and nonuniform movement, directly anticipating the infinitesimal calculus that transferred every type of space or movement into a continuous space. With advancing precision, temporal intervals infinitesimally converged on zero. Temporal perception was thereby mechanically specified, and later cast by Newton and Leibniz into mathematics. In our day, the computer is clocked by the ultra-fast oscillations of an electrically activated quartz crystal—down to units that escape human perception and that allow infinity to reappear in the infinitesimal

- ticking, wheeled clock signified that numbers were turning into machines (or that machines were becoming numbers), starting to prepare us for the advent of the Turing Machine, the modern computer of the twentieth century

- wheeled clock transforms Medieval "annalistic" macro-time into a microphysics of time.

- Aristotle, in a techno-constructivist rather than phenomenological way (like St. Augustin) defined time as motion to which numerical values can be assigned by measuring. It was Christian teleology that introduced the concept of an estimated vanishing point, which - in alliance with zero in mathematical calculation - produced a linear temporal perspective. With the advent of the wheeled clock, a rhythmic mechanism began subliminally to massage (in McLuhan's sense) the human sense of time, and its message came to be that the world could be perceived in terms of frequencies. The precise countability of time as movement (beginning with the ticking clock) eventually yielded world images such as those of film and line-synchronized electronic television. From this point, an advanced mathematical sense of time come into play: Leibniz' and Newton's infinitesimal calculus, which finally was related explicitly to the electronic media by Norbert Wiener = Norbert Wiener, *Cybernetics or control and communication in the animal and the machine* (Cambridge, MA: MIT Press, 1948)

- in Pythagorean aesthetics, harmony of integer numbers applying both to tonal oscillations and to planetary motion; with the development of the pendulum clock, mathematical counting of movement became autonomous, as a metronom to measure time

- With its mechanical escapement, wheeled clock produces precise temporal prosody in the form of a pulse sequence, with equal intervals; based on such oscillations, machines later generate audible sounds in technical form; sonic existence came to take place as being in time; "ringing gradually begins to break away from the geometry of monochord proportions; music begins to leave the space of Greek mathematics, to plunge into the eventful dimension of time" = Wolfgang Scherer, Musik und Echtzeit: Zu John Cages *4'33*, in: Zeit-Zeichen. Aufschübe und Interferenzen zwischen Endzeit und Echtzeit, eds. G. Christoph Tholen and Michael O. Scholl, Weinheim (VCH Acta Humaniora) 1990, 351-362 (356). This dimension can be called "media time." In his *Syntagma Musicum* (1614-1620), the organist Michael Praetorius related the symbolic order of the length of notes to the mechanical beat of the wheeled clock; Grete Wehmeyer, *Prestississimo. Die Wiederentdeckung der Langsamkeit in der Musik* (Hamburg: Kellner, 1989), 15

- metronome of Johann Nepomuk Maelzel (Vienna 1814), musical beat found its own medium, setting the terms on which the micro-time of physical acoustics would later become comprehensible through electro-technical measurement, "the necessary greater exactness [of which] is obtained by the electric current itself" = Hermann von Helmholtz, On the Sensations of Tone as a Physiological Basis for the Theory of Music [GO 1863], Whitefish, MT (Kessinger Publishing) 2005, 398; also Scherer 1990: 362. Ultimately, the electronic oscillatory circuit released the beat of time from all cosmic-religious remnants, in order itself to radiate in the ether.

- 1377 Nicolas d'Oresme compares movements of the celestial bodies with a wheeled clock in his *Libre du ciel et du monde* = Nicole Oresme, *Le livre du ciel et du monde*, edited by Albert D. Menot, Madison, Wi. (University of Wisconsin Press) 1968; specified the decisive element of the wheeled clock as the mechanical correlate to the ancient harmonic theory of the cosmos. Once set in motion by God, this system runs automatically. Even Leibniz conceived of his monads as clocks wound up by God: they "continued to keep time with one another like separate clocks, so that they appeared to communicate with one another; but this appearance is merely a deceptive consequence of their synchrony" = Norbert Wiener, Time, Communication, and the Nervous System, in: Annals of the New York Academy of Sciences, 50 (1948-50), 207 Monads were thus conceivable only via the wheeled clock as a standardized and standardizing instrument of measurement that also produced comparability in time. Norbert Wiener writes: "As a matter of fact, the automata made in the seventeenth and eighteenth centuries were run by clockwork," and today, more than ever, computing demands highly sensitive pre-existing temporal harmonies = ibid.

The Epistemogenic Artifact: the Wheeled Clock Escapement

- earliest mechanical clocks still retained principle of continuous driving force, such as water clock and in the water wheel. "It was about 1300 A.D. that the step was taken of momentarily interrupting rotary movement by a crown rod and balance wheel. This function was called 'escapement' and was the means of literally translating the continouous force of the wheel into the visual principle of uniform but segemented succession" = McLuhan 1964: 153

- "It was not the clock but literacy reinforced by the clock, that created abstract time and led men to eat, not when they were hungry, but when it was '*time* to eat'" = McLuhan 1964: 154

- in verge escapement of the wheeled clock, a technical mechanism became epistemogenic matter; description of the escapement's media-historical moment provides occasion to reflect upon some of the methodological implications of media archaeology; technically precise explanations carry epistemological weight; the art of media-archaeological (rather archaeographic) *ekphrasis* - comes into play; how escapement works: without such an intermittance, rotation of the axle would steadily increase in speed. "A crown wheel with an uneven number of teeth, mounted onto the axle or linked to it via a gear train, . . . alternately blocks and releases the verge by means of two pallets attached to the verge at a right angle to each other. . . . The duration of the oscillation of the inertial mass of the verge and the foliot can be adjusted by moving regulating weights on the foliot. . . . This to-and-fro, oscillating movement inspired terms for the device such like 'restlessness', 'foliot' (from a word describing a quivering leaf, first used by J. Froissart around 1370), even most metaphorically 'women's temperament'" = Dohrn-van Rossum 1996: 53; culture of the early modern period not only struggled with a new technology but also with a new language for describing it. Classical art of description had originated in rhetoric, based on linguistic figures; in contrast, new type of technological objects that emerged in early modern Europe demanded a new type of representation: the language of mathematics and of the technical diagram

- decisive feature of mechanical clockwork contained stored-up energy; spring tension produces pressure on the escapement mechanism, distributing minimal energy quanta into equal oscillations, which were then transformed mechanically into beats, placed on the border of pure information. Despite such a radical departure from existing clock technologies, introduction of the verge-and-foliot escapement barely mentioned in contemporary sources; only in retrospect described as "significant but mysterious", precisely because its mechanism could not be perceived at the interface of the clock face = Dohrn-van Rossum 1996: 46. Technical media achieve their effect by dissimulating their mechanisms: "In contrast, the appearance of striking clocks was registered instantly, and was felt to be technologically sensational and socially momentous" = ibid. Whereas the clock face can immediately be seen and heard, generating the effect of an advancing time, a glance at the escapement suggests an alternating oscillation rather than linearity; escapement thus constituted the first binary mechanism of positive/negative polarity, which ultimately became operative in electrical clocks and electronic clocking devices

- technological artifacts worthy of investigation in terms of their epistemic implications for media culture; every operative technology apt for media

theory. Respective to their material substrates and logical diagram, technical media, like the science that studies them, not purely discursive events. In contradistinction with the objects of classical archaeology, medial-epistemic matters are logical as well as material artifacts. Techical media manifest themselves exclusively through their operations, placing logic next to hardware and making the term *techno/logy* meaningful

- first generation wheel clocks ticked rather imprecisely; uniform oscillations of the horizontal pendulum (the foliot-escapement with verge) independent of the precisely wrought wheelwork of the clock. Improvements in the accuracy of time measurement achieved with Galileo's discovery of the laws of pendulum motion in 1641 and with their application to the design of a free, vertically oscillating pendulum by Christian Huygens in 1656. Huygens's pendulum escapement established a new basis for measuring time: the periodic oscillation itself, which as a unit of measurement remained valid through to the invention of the atomic clock in the twentieth century, which approached the oscillatory operations of sensory data processing in the human brain = Ernst Pöppel, Die Rekonstruktion der Zeit, in: Hannelore Paflik (ed.), Das Phänomen Zeit in Kunst und Wissenschaft, Weinheim (VCH) 1987), 29 f.

- ticking wheeled clock not an allegory of time but a time machine; its presence acoustically indicated by the striking mechanism; because its technical mechanism in most cases remains hidden from the observer behind the clock face (*dissimulatio artis*, or concealment of technology, as basic techno-rhetorical figure of all media effects), requires media-archaeological attention.

- principal work of such a clock called, in a telling *terminus technicus*, "timework"; hour-striking mechanism (and deriving from it, musical compositions programmed *via* a cylinder with pins) controlled discretely / digitally. Otherwise, on the visible "analog" surface, motion of time appeared continuous. In the form of kinetic notation, the clockwork might be portrayed in diagrammatical terms: a kind of programming *avant la lettre*; Franz Reuleaux, Theoretische Kinematik. Grundzüge einer Theorie des Maschinenwesens, Braunschweig (Vieweg) 1875

On the Ritual and Liturgy of the Wheeled Clock: Media Archaeology versus Media Anthropology

- ticking clockwork resulted in an abstraction from cosmic time that could still be experienced empirically; mechanism of the verge-foliot escapement allowed the motion of a weight-driven axle to be controlled in such a way that its uniform rotation became suitable for use as a time standard such as the equinoctial hour in Benedictine monasteries = Dohrn-van Rossum 1996: 48; wheeled clock became a chrono-poietic (time-giving) instrument and established a time abstracted from nature. "For the first time in world history, mechanical reproduction emancipates a work of art from its parasitical dependence on ritual", Benjamin remarks on photography = Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit, Frankfurt (Suhrkamp) 1963, 17; also Jonathan D. Kramer, The Time of Music, New York / London (Schirmer) 1988, 68; such emancipation had already occurred within the temporal regime

- ceremonial, ritual, rhythm, and repetition all cultural techniques for making time symbolically steady = Hartmut Böhme, Vom Cultus zur Kultur(wissenschaft). Zur historischen Semantik des Kulturbegriffs, in: Renate Glaser and Matthias Luserke, eds., Literaturwissenschaft - Kulturwissenschaft. Positionen, Themen, Perspektiven, Opladen (Westdeutscher Verlag, 1996, 55; culture practices as negentropic expenditure of energy: maintaining symbolic order against the second law of thermodynamics, according to which particle movements tends towards equal dissipation *alias* disorder

Culture is technical in its sense of standardization and ritualization, but only with the escapement-controlled wheeled clock did media time emerge in a well-defined sense. Even if ritual and ceremony already represented a form of temporal regularity and performance, those instructions were still like handwriting in comparison to typography / machine writing: variable in their concrete theatrical manifestations; in the working world of modernity, "ritual is replaced by the precise, technical operation" = Ernst Jünger, Über den Schmerz, in: Blätter und Steine [orig. 1934], 2nd ed. Hamburg (Hanseat. Verlagsanstalt) 1941, 208

- technological *routine* ("path of habit") denotes a "fragmenting of work into simpler motor functions that can slowly be combined" = Hugo Münsterberg, Grundzüge der Psychotechnik, Leipzig (Barth) 1914, 559; in discrete, digital systems "[a]ny step is [. . .] as important as the whole result" = John von Neumann, General and Logical Theory of Automata, in: idem, Collected Works, Vol. V: Design of Computers, Theory of Automata and Numerical Analysis, ed., A. H. Taub, Oxford (Pergamon Press) 1951, 292

- escapement-controlled timepiece much more than a trivial mechanism but a cybernetic, that is: feedback-regulated system; in order to understand its isolation / autonomy from its human setting requires forgetting that it was made in the first place in response to specific human needs = J. D. North, Monasticism and the First Mechanical Clocks, in J. T. Fraser and N. Lawrence, eds. The Study of Time II. Proceedings of the Second Conference of the International Society for the Study of Time, Berlin / Heidelberg / New York (Springer) 1975, 381; once such a mechanical clock is put to work, its functions depend on a genuinely media-governed logic, indifferent to whether it is being applied in a medieval monastery or in a present-day museum; message of this media mechanism is not only the acoustic signal that human ears decode as an indicator of temporal measurement, rather a media-physical reminder of frequencies and oscillations, rhythm and repetition as basic media-archaeological ingredients

- innovative media-epistemological feature of the mechanical clock, the coming into being of the mechanical escapement in the thirteenth century, as much bound to moments of cultural history as to techno-logical laws operating in an ahistorical temporal register, and its "tradition" is as much a function of the survival of knowledge about wheel-driven clocks (astrolabes) from antiquity into medieval times as it is part of a techno-logical self-reference that is only partly identical with the discursive variations of human history

- verge-and-foliot escapement = decisive mechanism that distinguished the "truly mechanical clock" from traditional astronomical mechanisms; *later* (or functionally) re-/displaced by the pendulum. Periods of swing (oscillations) been part of cultural knowledge but restricted to the observation of planetary systems for agricultural use, became fundamental parameter in the measurement of micro-temporal events; insights of media-operative measuring opened up a world of time-critical operations hitherto unknown to human perception (in the original sense of *aisthesis*). Media archaeology does not aspire to explain the ways in which the oscillatory mechanism used for both measuring time and striking a bell in the thirteenth century were absorbed into cultural discourse such as the high ritual of the church. The canonical hours of the monastic life—especially according to the Cisterian rules (such as Rule XCIV, which referred both to *horologium temperare* and *facere sonare*) —almost inevitably engendered the demand for some sort of automatic control. With clockwork, control was given over to the time of automata. But the driving energy behind the development of the mechanical clock—the desire to cause a clock to sound on its own—operates on a level that is not restricted to religion. Parallel to the unfolding of cultural logic, something else is at work. Media archaeology pays attention to what was established on a subconscious level prior to culture and religion: the training of a sensibility to micro-temporal events

The Anachronism of the Ticking, Wheeled Clock

- chronological origin of the time-giving mechanical escapement-driven clockwork itself literally escapes historical narrative: "No entry in a chronicle, no narrative account, no description of the construction makes the invention an event we can date or locate" = Dohrn-van Rossum 1996: 46; early weight-driven clock in Cathedral of Strasbourg, built by Henri de Vick (Wieck) between 1362 and 1370. Around 1320, Dante Alighieri describes in the *Divine Comedy* a wheeled clock with a mechanical escapement. Notwithstanding such references, invention of the verge-and-foliot escapement-driven clock belongs to what Sigfried Giedion describes as anonymous history = Siegfried Giedion, Mechanization Takes Command, Oxford (Oxford University Press) 1948. Although an astronomical clock furnished with a kind of escapement mechanism had already been introduced into China in the year 1092, Gerhard Dohrn-van Rossum considers the foliot escapement as "in all likelihood an independent European development" = Dohrn-van Rossum 1996: 105; strictly media-archaeological argument. Chinese clock contained an escapement made by pivoting: "balance levers that stabilized a stop-and-go motion. The principle of the European escapement, which employs the centrifugal force of an oscillating inert mass, does not resemble it in any way whatsoever" = van Rossum 1996: 87. Only on a technically close reading does this difference come into view. As Joseph Needham writes, "We cannot rule out the possibility of completely and independently parallel lines of thought occurring in widely separated parts of the world" = Joseph Needham, The Shorter Science and Civilisation in China, Vol. 1, ed. Colin A. Ronan (Cambridge: Cambridge University Press, 1978), 58. Therefore another temporal order, one that reacts asymmetrically to the temporal economy of telling the "origin" of the escapement as a moment precisely registered in historiography; media archaeology refers more to the discrete time of machines as to the symbolic

time of human culture called "history". The digital beat of clockworks and the discrete series of letters in archival records are different kinds of non-narrative temporal information.

- wheeled astronomical clock at St. Mary's Church in the city of Rostock still ticking today; has been preserved in its original form and is fully functional since 1472, with parts of its mechanics incorporating a precursor clock from 1379; Manfred Schukowski, Die astronomische Uhr der St.-Marien-Kirche zu Rostock, Rostock (no publisher indicated, brochure) 2004, 4. The constant ticking of this clock questions the (self-)temporality of such chronomedial systems: a kind of media time that escapes the discourse of history. Media archaeology involves an effort to capture this media-inherent microcosm of time.

"Nor is it fitly said, 'There are three times, past, present, and future'; but perchance it might be fitly said, 'There are three times; a present of things past, a present of things present, and a present of things future'" = St. Augustine, The Confessions of St. Augustine, Bishop of Hippo, Book XI, Chapter XX, trans. and annot. J. G. Pilkington, Edinburgh) (T. & T. Clark), 1876, 306. Augustine thereby implicitly describes the condition of an intact clock. Among the peculiarities of technical media is the fact that they behave negentropically toward the flow of time. Technical media reveal their essence only by occurring in the present. All *arché*, all origin, is dissolved in this taking place; historicist notion of the "Middle Ages" dissolve into the tick of the wheeled clock as it takes place today

- escapement-driven wheeled clock the opposite of a mnemonic medium: its stored energy (the wound-up metal spring) is a physical-energetic memory, intermittently converted into information (time designation) and comparable to the electromagnetic relay used in binary digital memory. Technological time and historical time differ fundamentally. Commenting on paragraph 80 of Martin Heidegger's *Being and Time* (1927), the chapter concerning clocks, Friedrich Kittler notes that Heidegger did not haphazardly switch from a fundamental-ontological description to a positivistic, cultural-historical description. According to Kittler, Heidegger's dilemma was this: "A history, which is essentially time, intersects with another history, through which the machines of time-measurement themselves pass. Clocks are ontic devices, thus subordinated to fundamental ontology, which nevertheless bring about historically different ontologies" = Friedrich Kittler, Eine Kulturgeschichte der Kulturwissenschaft, Munich (Fink) 2000, 235 f.

Hindrance time

- abstract, quantitative time of watches and clocks took over the regime of qualitative religious time; "homogeneous and desacralized time" (Henri Lefebvre), culminating in chronophotography, the technical measurement of the smallest temporal units in working processes in order to optimize production" = Henri Lefebvre, Rhythmanalysis:. Space, Time, and Everyday Life, London / New York (Continuum) 2004, 73; replacement of metaphysics of a continuous time by a model of discrete pulsing represents not only a culturally

historic but also an epistemological shift. In Occident, time of clocks literally introduced bit by bit, with this phrase being more than just a wordplay

- What appears on the "analogue" clock face as a smooth temporal progression (unless indicated by second index) dissolves into "digital" machine counting from a media-archaeological perspective; metonymically, the view of the clockwork itself. In Heidegger's words: "Time is not. There is, It gives time. The giving that gives time is determined by denying and withholding nearness" = Martin Heidegger, Time and Being, in: idem., On Time and Being, trans. Joan Stambaugh (Chicago: University of Chicago Press, 2002), 16

- infinite or negligible impedance between the two poles of a switch technically called *hindrance*. Its mechanical precursor is the escapement. Through the functioning of the escapement, time counts in binary form. What alphabetic writing accomplished for the phonetic stream of speech, the wheeled clock achieved for time: a radical individuation, a core of occidental combinatory rationality. Ultimately, the sampling practice of signal engineering is at hand, in which individuation means the replacement of an infinity of consecutive values with a finite number of values; Claude Cadoz, Les réalités virtuelles (Paris: Flammarion, 1994), 85. Such a quantification of values changes its temporal essence: "Between 0 and 1 there is no time. . . . It is the hindrance that gives the 'discretized' [*diskretisierte*] time" = Bernhard Siegert, Passage des Digitalen. Zeichenpraktiken der neuzeitlichen Wissenschaften 1500-1900, Berlin (Brinkmann & Bose) 2003, 9; also Claude Elwood Shannon, A Symbolic Analysis of Relay and Switching Circuits, in: Transactions American Institute of Electrical Engineers vol. 57 (1938), 713-23; tick of the clock that originated in the monastic order returns in the time-discrete formation of digital computing. In the guiding principle of the so-called von Neumann-architecture for computers, commonly in use today, this sense of time is still operative. "One thing at a time, down to the last bit!" = William Aspray and Arthur Burks, Computer Architecture and Logical Design, in: William Aspray / Arthur Burks (eds.), Papers of John von Neumann on Computing and Computer Theory, Cambridge, Mass. (MIT Press) 1987, 5 f.

Bulova Accutron

- tuning fork, coupled to an electro-magnetic coil (as developed by Hermann von Helmholtz as electro-mechanic device to measure the micro-temporal run time of nerve impulses), provides the time base in the Bulova *Acutron* watch; German "Stimmgabeluhr", formerly advertised: "The Tick vs. the Hum". A sine tone here serves as time-giving media event - not for acoustical or even musical sake, but in implicit sonicity: the tempor(e)ality of sound which is shared by processual technologies

- non-metaphorifcal, core agency of synchronization is communication between nonlinear oscillators which adjust heir rhythms due to weak interaction. Literally, "emerging synchronization" has been Christiaan Huygens' 17th century observation of two pendulum clocks suspended in the same wooden beam whose motions were "so much in agreement that they never receded the least bit from each other and the sound of each was always heard simulateneously" = Horologium Oscillatorium, as quoted in: Michael Rosenblum

/ Arkady Pikovsky, Synchronization: from pendulum clocks to chaotic lasers and chemical oscillators, in: Contemporary Physics, vol. 44, no. 5 (September / October 2003), 401-416 (401). By such *coupling*, the implicit "sonicity" of synchronization (named "le phénomène de la sympathie, sympathie des horloges" by Huygens = quoted ibid.) becomes explicitly acoustic. "These features are typical not only of clocks, but also of many oscillating objects of diverse nature" - generalized sonicity <402>. "Mathematically, such an oscillator is described by an autonomous (i. e. withpout explicit time dependence") nonlinear dynamical system" <402> = invariant in regard to "historical / cultural" time, rather *eigenzeit*. Beyond acroamatic fixation of that time-critical phenomenon to the audible by human ears, the effects was applied by E. V. Appleton and B. Van der Pol to exact triggering of vacuum tube triode generators as basic condition of radio electronics; soon afterwards in 1920, W. H. Eccles and J. H. Vicent "coupled to generators which had slightly different frequencies and demonstrated that the coupling forced the system to vibrate with a common frequency" = Rosenblum / Pikovsky: 402. Obviously, "the frequency of a generator can be entrained, or synchronized, by a weak external signal of a slightly different frequency" = ibid.; *entrainment* therefeore does not only relate to the adaption of human neurons to musical rhythm.

- not confuse such synchronization with another phenomenon in oscillatory systems which is resonance: the response of a system that is non-active, i. e. demonstrates no oscillations without external driving, different from self-sustained oscillations without external forcing - such as the radio-controlled clock where the radio signal from the sender is meant only to adjust or correct the oscillations, vs. the railway station clock which actually stops when the electric impulse from the central master clock ceases <403>.

- in chaotic multi-oscillatory systems, one observes the emergence of local synchronization <412> which can be observed on the oscilloscope (Lissajous-like figures for synchronous regimes, vs. random distribution for the asynchronous regimes) = 406, Fig. 4; cp. Chua oscillator; Siehe T. Matsumoto, A chaotic attractor from Chuas's circuit, in: IEEE Transactions on Circuits and Systems, 31/12 (1984), 1055-1058

- tuning fork-based electronic clocks driven by frequencies within the audible range ("tonfrequent", 360 Hz /cps) - in reverse of philosophical or aesthetic speculations on "time and music"; ends with the subsequenz Accutron 2 series with quarz crystals as clocking device: ultra-sonic. But here is still sound, this time implicit; centre of this system = piezoelectric *resonator*

- Shaul Katzir, War and peacetime research in the road to crystal frequency control, in: Technology and Culture 51 (2010), 99-125 http://humanities.tau.ac.il/segel/skatzir/files/2012/03/TC-Cady-published3.pdf; impossible without valve / transistor electronics; Cady's discovery: quartz crystals display very sharp / stable electric resonance. Resonance, as expressed by the very *terminus technicus*, implicit sonicity: the tempor(e)al of immediately coupled system when addressed in their *eigen* frequency; resonant circuit (German "Schwingkreis") as basis for radio & television (and current mobile communication) devices; Bell Labs searched for highly accurate / stable method for measuring frequency rather than time; underlying media-theoretical bias: replace the despotic, transcendent signifier TIME by the

plurality of dynamic events actually taking place

- to coordinate / synchronize complex communication networks, American Telephone and Telegraph Company / national laboratories needed to determine / maintain common standard frequency measurement unit. Exploiting novel piezoelectric quartz methods and electronic circuits, new crystal-based frequency standard

- watch company Timex partnering with SilMach (for practical Microelectromechanical systems devices), "to create watches that take advantage of a new type of very efficient, low-energy electrostatic motors [...]. Analog quartz watches today rely on so-called Lavet stepping motors"; Marius Lavet's patent granted in 1936; here "the rotor, rather than moving continuously, advances in discrete jumps" - also weniger "analog" denn diskret in ihrer Materialität; has made years-long battery lives possible (along with long-life lithium cells). "Thanks to the geometry of the rotor and stator (the moving and stationary parts of an electric motor's core, respectively) the rotor of a Lavet stepping motor will also remain fixed in position between jumps"; advantages for controlling the position of the hands of an electrically driven watch. [...] rather than using a standard electric motor with a rotor-stator setup, the PowerMEMS motor relies on two silicon arrays made up of dozens of combs with interdigitated teeth; current passing through the combs induces alternating movement thanks to electrostatic forces; this lateral movement then translated to rotational movement by a system of two pawls interacting with a toothed wheel; "the whole arrangement is somewhat reminiscent of an Accutron tuning fork movement, which similarly turns the lateral vibration of the tuning fork into rotation via a pawl and wheel system" - setting the media-theatrical stage for nano technology" = Jack Forster, "Technical Perspective", June 23, 2017: https://www.hodinkee.com/articles/timex-to-partner-with-nanotech-firm-silmach-to-produce-revolutionary-micromotor-for-quartz-watches; accessed June 26, 2017

THE MESSAGE OF CURRENT COMMUNICAITON MEDIA

Electricity: The media-archaeological index of McLuhan's media theory

- electronic speed of wireless or cable-based commmunication such as telephony does not involve physical or mechanical transportation vehicles any more ("electrons"), being almost completely liberated from matter and energy and rather taking place as world of contiguous pulses; Marshall McLuhan's diagnosis of a return of the audio-tactile in the world of electronics. Speed must be conceived here not primarily as conquering of space (movement) but as ultra-short temporal moments - as fast as thinking itself

- McLuhan's analysis of electrically configured media / Paul Virilio's dromology; speed at which information travels, undoing spatial distance by almost synchronous communication which McLuhan identifies as "the electric environment of instant circuitry" = McLuhan 1964: x. McLuhans concern was that "the action and the reaction occur almost at the same time". Humans lose the detachment with the information they are dealing with and hence "the power to act without reacting" <McLuhan 1964: 20>. What McLuhan means is

the speed-up of information flow with electricity-based media which he opposed to what he described as the linear communication diagram of Claude Shannon. What he did not anticipate was bit-based media which can emulate and even undertunnel electronic speed by mathematical intelligence to what we now call *real time*. (and the so-called Real Time Internet).

- McLuhan interpreted electronically mediated communication as a contraction of the global world into pure tele-presence (thus anticipating what Paul Virilio developed further in his "dromology"). This contractions is not primarily a spatial one but of a temporal nature. This does not mean an alienation of humans from nature by techno-culture but, on the contrary, his coming-into-being: The electric age, according to a guiding thesis in McLuhan's *Understanding Media*, has technically extended the central nervous system up to the point that not only mankind is interrelated but assembled within.[7]

In times of Internet protocols McLuhan's thesis requires closer reading. What he has described metaphorially has become literally true. Time-critical processes take place in its most media-archaeological sense, that is: on the basic layer of bit transfer in the, the *physical layer*. This layer represents the interface of symbolic transfer to the material (or electro-magnetic) channel of communication (such as copper cables, wireless directions, light waves lines) and thus embodies very concretely the interlacing of logi(sti)cs and matter which is already implied in the term "technology". It is on this layer that the voltage level of what is meant to represent a logic "zero" and a logic "one" is being defined. The function of this bit transfer layer is in the transformation of signals within a physical transfer channel into information in order to be passed further to level two of the OSI system.[8] This identification of signals happens within the time-critical field, such as signal frequency and signal duration, sychronous or asynchronous clocking, and the decision on serial or parallel data transfer.

- classic "analogue" model of mediated communication which is channel-based transmission (tele-communication in the spatial sense, tradition in the temporal sense) is under-tunneled by mathematically sophisticated transfer time calculating "real time" effects by means of statistical anticipation of immediately future events

McLuhan at the borderline of digital computing

- McLuhan's emphatisis on electricity hampered him to conceive the computer otherwise than just in anecdotes. Maybe this was the case because he saw in the ancient Greek phonetic alphabet a kind of original sin of the occidental psyche and culture of knowledge since it replaced collective *mimesis* by individualized objectivity.

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7 Marshall McLuhan, Die magischen Kanäle. Understanding Media, Düsseldorf/Wien (Econ) 1968, 10

8 Christoph Neubert, Elektronische Adressenordnung, in: Stefan Andriopoulos et al. (Hg.), Die Adresse des Mediums, Köln (DuMont) 2001, 34-63 (41)

and privileged linear, analytic, visually based acquisition of information, resulting in the "euklidic control system.

- required three thousand years to unbound a kind of power which is the opposite of the alphabetically elementary "Euclidic centralism" - electricity with its acoustic qualities =Bruce Powers im Gespräch mit McLuhan, in: Marshall McLuhan / Bruce R. Powers, The Global Village. Der Weg der Mediengesellschaft in das 21. Jahrhundert, Paderborn (Junfermann) 1995, Kapitel "Von Engeln zu Robotern: Vom euklidischen Raum zum einsteinschen Raum", 169-184 (178)

- With media-communicative uses of electricity, McLuhan's discovers the age of a new technical form of tactility = Till A. Heilmann, Digitalität als Taktilität. McLuhan, der Computer und die Taste, in: Zeitschrift für Medienwissenschaft 3, 2/2010, 125-134 (128). This tactility though is different from the operations of the symbolic machine called typewriter (discrete fingertips).

- chapter 11 of *Understanding Media* defines the nature of the number as "an extension and separation of our most intimate and interrelating acticity, our sense of touch" = McLuhan 1964: 107 - when fingers are used for discrete counting; counting in times of mechanized mathematics takes another dimension

- McLuhan's *Understanding Media* finishes with a chapter on "automatization"; up to this limit the author in 1964 perceives the computer.[9] McLuhan, with his servomechanistic concept of man-machine symbiosis, heavily refers to the cybernetic epistemology of his days, but significantly blinds out its mathematical foundation on which Norbert Wiener always insisted - a mathematization which ultimately replaced McLuhan's vision of a synchronous, instant and resonant "acoustic space" by digital calculation.

- essential von-Neumann architecture of current computing as algorithmic and storage-programmable symbolic machine acknowledged only in the posthumly edited work by his son Eric McLuhan, *Laws of Media*). But here again, in the best tradition of the central thesis of *Understanding Media*, McLuhan (both father and son) try to identify the central "message" (articulation) of the digital computer, less than its social impact which has been dominated by the "Personal Computer" concept and Graphical User Interface since, followed by the interconnectedness of computers by the Internet and the so-called "Web.2" economy.

- learn from the McLuhanite method is to resist the temptation of submerging the analysis of current media culture to the "cultural studies" and "social media" approach which looks at the figurative *Medienwirkung* (the social phenomena); apply his real media-archaeological analysis instead which identifies the deep impact of a current media system; McLuhan calls it, according to the *Gestalt* approach in psychology, the "ground".

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9 See Jens Schröter, Von Heiß/Kalt zu Analog/Digital. Die Automation als Grenze von McLuhans Medienanthropologie, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (Hg.), McLuhan neu lesen. Kritische Analysen zu Medien und Kultur im 21. Jahrhundert, Bielefeld (transcript) 2008, 304-320

- McLuhan's media theory can not be updated in a linear way (as understood in signal processing: linear signal transfer between input and output), but rather as a toolbox, opening an awareness for media-induced phenomena acting upon humans. In an uncanny way, McLuhan transforms from a hostoriced media theorist into an up-to-date model exactly when reading him in his posthumous work, that is: almost alive. This inbetween-time (almost alive, nevertheless dead) is part of the argument already. All of a sudden, McLuhan seems a little bit less dead, when reading his identification of computing media as a machine whose essential message is rooted in its delicate time mangement. Under this aspect, the computer as the dominant medium of today can not only be understood better, but turns out to be a chrono-poet itself, thus actively reshaping current culture on the basic level (or *a priori*) which George Kubler once described in his *Shape opf Time*. Even though this insight has been borrowed from other scholars as ever in McLuhan's fast-processing works, it is directed by a remarkable skill to identify the crucial and original arguments: "Jeremy Rifkin shows that, thanks to the computer, visual centralized time is a s obsolte as visual space. The Central Prcessing Unit orchestrates a ballet of operations in simultaneous times, chronology in counterpoint" <Marshall McLuhan / Eric McLuhan 1988: 53>. This is an understanding of *mousiké* in its ancient Greek sense. Here, McLuhan comes close to what has recently been termed the "algorhythmic" (Shintaro Miyazaki)[10] - carrying his notion of "acoustic space" into the digital kernel.

- computer not just time-based as performing arts and technical media before, but becomes itself chrono-poetical. A distinguishing feature of the computer is "its temporal creativity" <Marshall McLuhan / Eric McLuhan 1988: 53>. Refering to David Bolter's *Turing's Man*[11], McLuhan points out "that while clocks are all set to the same exacting sequence, duration, and rhythm, the computer is free to manipulate all three of these temporal demensions by merely changing the program" <ibid.> - which is true especially for the von Neumann architecture of computing, a concrete embodiment of the algorithms - which is being-in-the-world, and thus: in time.

Ivan Sutherland, head of the Asynchronous Research Center at Portland State University, points at the still clock-like mechanistic concept of distributing time within a computer (clocking). The asynchronous, on the contrary, allows every modular process to finish at its own pace; concept of data flow computing

- "Bolter argues that time is a resource for the compute just as coal is the resource for the steam engine" = Marshall McLuhan / Eric McLuhan 1988: 53 - an oblique metaphor: Would it be rather temporal information (neither matter nor energy)? The difference between clocks and computers, McLuhan underlines, is that "an ordinary clock produces only a series of identical seconds, minutes and hours, a computer transforms seconds or microseconds or nanoseconds into information" <Bolter 1984: 102f>. McLuhan continues: "With this new timepiece, time is no longer a single fixed reference point that exists external to events. Time is now 'information' and is choreographed

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10 Shintaro Miyazaki, Das Algo*rhythmische*. Microsounds an der Schwelle zwischen Klang und Rhythmus, in: Axel Volmar (ed), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009, 383-396
11 David Bolter, Turing´s Man. Western Culture in the Computer Age, Chapel Hill (The University of North Carolina Press) 1984, 38f

directly into the programs by the central processor" <Marshall McLuhan / Eric McLuhan 1988: 53>; this "choreography" is media theatre in its dramtic, time-operative sense. "With computers we enter the age of 'multiple times'. Every program has its own sequences, durations, ryhthms, its own unique time" = Marshall McLuhan / Eric McLuhan 1988: 53, referring to David Bolter

"While the clock establishes the notion of artificial time segments - hours, minutes, and seconds - it remained tied to the circadian rhythm. The clock dial is an analogue of the solar day, an acknowledgement that we perceive time revolving in a circle, corresponding to the rotation of the earth. In contrast, computer time is independent of nature: it creates its own context" = Marshall McLuhan / Eric McLuhan 1988: 53. Genuine media time is *Eigenzeit*: "In acoustic space, every thin or event creates its won space, and time" = Marshall McLuhan / Eric McLuhan ibid. "The computer imprints a unique temporality into every program" = Marshall McLuhan / Eric McLuhan 1988: 53 - all the difference between an alorithms written with pencil on paper (like a musical score) and its implementation as a running program (like a musical performance). The message of the computer as medium is this tempo-reality

- McLuhan quoting Daniel Bell, *The Clock Watchers*, 55: "The electronic timer provides the measure by which the processor ticks its way through its calculations, ensuring <...> that one step is finished before the next is begun. The instructions themselves may require varying amounts of time ... This variation must be taken into account by the sequencing mechanism, which decides how many pulses of time to allot to each instruction" = Bell, as quoted in: Marshall McLuhan / Eric McLuhan 1988: 53; timing mechanism within the computer brings it close to rhythms (in the Aristoxenean sense who coined the term *chronoi* for measuring the temporal duration in music, dance and prosodic speech)

Short-cutting the channel: Diagram and topology instead of "mobility"

- tracing tempor(e)alities in the age of media mobility: mobility associated with linear ("analog") migrations and non-linear ("digital") dislocations in topological space and time. But within the *temporal* and diagrammatic dimensions of mobility in media-based communication the despotic signifier "time" itself implodes, resulting in the necessity for alternative descriptions of the dynamics within the chrono-poietical field; the plausibility of "mobility" for analysing the current condition might turn out to be an antiquated remnant of modernism which blinds the insight into the topologies, diagrams and graphs of networked (chrono-)spheres.

- "serial" time - known from television as program format - is part of the geometrization (mathematization) of time (as opposed to entropic "natural" time).

- term "mobility" lags behing; left-over from discourse of modernity (its transport systems); in "digital" present times, rather techno-mathematical topologies ("Internet traffic") and heterochronotopies

- radically new, mathematic forms of trans-temporality

- networked locations can be addressed with the speed of electricity; replace the still energetically biased notion of "mobile" transfer

- Paul Baran and Donald Watts, in 1963, develop *packet switching*; Bob Kahn and Vinton Cerf: Transmission Control Protocol (TCP), later accompanied by Internet Protocol (IP), transforming postal epoque of transmission-orientierted media to almost immediate adress orientation

- replacing the cultural formation called "tradition" (in its fixation on the temporal channel) into a dynamic archive, by primacy of techno-mathematical coding / compression

- emphatic transmission (across spatial distance) by a channel is undone (or counter-matched) by pre-emptive mathematical calculation on the one hand, and re-placed by micro-transmission (Wendy Chun)

- in binary code, thermionic tube (von Lieben) as amplifier in the discrete mode (*regenerative repetitor*), different from linear amplification in telephone or radio technology. This different bridging of distances by binary quantities results in a new quality: "The network became machine. No longer was the network a passive device, for repeater amplifiers actively added energy along the route. This change decoupled the wave that represented the conversation from its physical embodiment in the cable. <...> Electricity in the wires was now merely a carrier, separate from the message or signals it carried <...>. Now voices becames signals <...>. The message was no longer the medium; now it was a signal that could be understood and manipulated on its own terms, detached from its physical embodiment" = David A. Mindell, Between Humans and Machine. Feedback, Control, and Computing before Cybernetics, Baltimore / London (Johns Hopkins University Press) 2004 [Erstausgabe 2002], 112

- *regenerative repetitor* does not amplify, with signals, as well the noise, but clearly differentiates binary *digits*. Information replaces energetically continuous time-signal in favor of time-discrete pulses

- Bell System "became not merely a set of voice channels but a generalized system capable of carrying any signal as a new currency: information" = Mindell 2004: 107

- real-time computing, or "reactive computing" = hardware and software systems that are subject to a "real-time constraint", operational deadlines from event to system response; such needs addressed in the context of real-time operating systems, and synchronous programming languages, providing frameworks on which to build real-time application software. "A real time system may be one where its application can be considered (within context) to be mission critical" = http://en.wikipedia.org/wiki/Real-time_computing

- term *real-time* derives from its use in early simulation. While current usage implies that a computation that is "fast enough" is real-time, originally it referred to a simulation that proceeded at a rate that matched that of the real process it was simulating. Analog computers often capable of simulating much *faster* than real-time, a situation that could be just as dangerous as a slow

simulation if it were not also recognized and accounted for

- techno-epistemological turn: digitizing communication channels results in transforming the *time* of transmission into numbers

THE UNTIMELINESS OF MEDIA

Tempor(e)alities of archival and technical media as a challenge to cultural and historical time

- technological media not just an escalation in cultural techniques, but develop self-referential, auto-poetic tempor(e)alities which alter or irritate the established phenomenological categories of "inner" time perception and cultural memory. Such new chrono-poetic figures require a close reading of actual technical operations within time-critial and time-based media (their tempo-realities), while challenging the notion of traditional philosophy of time in favor of genuine media-temporality; Bill Viola, The Sound of one-line Scanning; John von Neumann, Report on the EDVAc, 1945; M. Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008 (special emphasis on the hard disc / computer storage)

Re:play. The lack of a sense of ending in technological media

Any enjoyment of a musical performance which is done by real (human) presence in real time and space (be it oral poetry as sung by Homer, be it a muscial concert) is always already accompanied by melancholic knowledge (that is: the irony) of its ending. On the contrary, audiovisual machinic recordings (the gramophone disc, the video tape) can be replayed with no internal sense of ending. To modify Walter Benjamin's analysis on "The Work of Art in the Age of Technological Reproducibility", with technical re-petition the temporal aura (which is based on the allegorical awareness of ending) is lost.

- with photography, the unique temporal moment / (expusure-extended) "now" becomes reproducable (Roland Barthes) - extended to life-as-movement by kinematography. While the traditional archive of predominantly textual records provides a spatial order ("l'espace de l'archive", as described f. e. by the historian Michel de Certeau), to be transformed into "history" by the very act of writing, the audio-visual archives themselves take place in time.

- "Zeit" in German a noun, suggesting substantiality; in English, though, there is as well the verb *to time*, *timing*" - and only Heidegger dared to make use of the word "zeitigen". The same structure happens for "end" ("Ende"), leading to *ending* - a temporalization of "time" and "end" themselves

Beholding the end

- *Beholding the Big Bang* (2009) Arthus Ganson constructed a sort of time keeping machinism which starts with 200 cycles of an indented wheel per

minute; this movement is sucessively translated and slowed down by sucessive wheels. The last wheel, though, which will be addressed only in thousands of years, is immutable, closely imbedded in a concrete block.[12] Does the first wheel, through its very materiel embedding in the whole system, have a *dissipative* sense of the ending from the beginning?

- "Through isochonric oscillation the pendulum can exist as the autonomous embodiment of natural or physical time" <Mackenzie 2001: 244>. But always loss of energy / damped oscillation: the moment of contact between the suspended pendulum and the actual clockwork. This *momentum* asks for description "in strictly thermodynamic terms, as a dissipative system" = Adrian Mackenzie, The Technicity of Time. From 1.00 oscillations/sec. to 9,192,631,770 Hz, in: Time and Society, Bd. 10, Heft 2/3 (2001), 235-257 (255, note 16), referring to: I. Stengers / D. Gille, Time and Representation, in: Power and Invention. Situating Science, Minneapolis / London (University of Minnesota Press) 1997. The motions of the pendulum and the moments of its contact with the escapement build "a cycle which converts potential energy to kinetic energy, and energy to information" <ibid.>

The "sense of ending" (Kermode) in narrative and music

- historiographical narrative *versus* media time; "historical memory" necessarily asks for narrative form of representation; past / storage may as well be computed (between *conter* and *raconter*, in French) - a mode actually closer to the archive, the *histoire serielle* as proclaimed by the French historians around the École des Annales[13]; different form of (non-)writing history, operating with variables in a process of truly mathematical analysis, algorithmical procedures

- in human physiology, no locatable "sense of time" as it is manifest in the optic, the haptic, and the other biological senses. But still there is something like a "sense of time", but this experience of time (see Edmund Husserl, "inneres Zeitbewußtsein") does not necessarily involve a sense of ending since this is a specific product of narrative time.

- decisive marks of narrated time are beginning, middle (or climax) and end, connected by a time-line on which the narrative unfolds towards the ending. Storage or memory time, on the oppositve, is "empty time", not dynamically unfolding, but invariant *stasis*[14]

- narrative as cultural form of ordered communication always already implies a sense of an ending. But the sense of (an) ending is not necessarily clothed in narrative form.

Narrative (both as literature, as oral performance and as musical composition) carries the signature of its ending (a Kermodian "sense of ending") already

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12 Exposed at: Labyrith::Freiheit, 2009, Festung Franzensfeste, Italy; documented in the catalogue, Bozen (Athesia Verlangsanstalt) 2009, 128f
13 See François Furet, Qunatitative History, in: xxx
14 Götz Großklaus, Medien-Zeit, Medien-Raum: zum Wandel der raumzeitlichen Wahrnhemung in der Moderne, Frankfurt/M. (Suhrkamp) 1995, 47

from the beginning. "Music always knows the end", Ernst Bloch describes the narrative dramaturgy of musical composition.[15] What is speficic with musical time (with music counting as time-based art) is the time-critical mirco-dynamics of its temporal order, thus modelling temporality (German "Vergänglichkeit") as such. The human perception of a melody takes place on the basis of a micro-temporal mechanism in consciousness, identifiable as neuronal correlation in the brain regions - a different, cybernetical drama unfolding below the narrative level, closer to mathematical counting (of time).[16]

- linear time characterized by sequentially unfolding, aim-directed events, with the singular events being linked causally to each other unfolding. The effect is the impression (and ideology) of a temporal continuum created by a succession of events in which earlier events imply later ones and later ones are their consequences.[17]

Ludwig van Beethovens' string quartett op. 135, for example, initially performs this step-by-step integration of apparent divergent moments, linearly aiming at a *quasi*-Hegelian dialectical synthesis (the end). "These processes give the movement a sense of forward motion through time" <ibid., 123-136>.

- sonic temporality (somewhat inbetween, media-theoretically *metaxy*) conditioned by the physical and physiological laws of acoustics, and by cultural training. Kramer points to this cultural condition of this temporal aesthetics, as a function of the occidental philosophy of progress.[18] A process-oriented analysis of musical dynamics in occidental musical art reveals that is has been mostly directed towards an aim towards it unfolds progressively. Against this eurocentristic temporality, Kramer describes non-linear temporal aesthetics - a "temporal continuum that results from principles permanently governing a section or piece", like known from the isorhythmic motette with its constant pattern of the rhythmical process (a "post-historic" condition). For several reasons - one of which is the technomathematical development of electronic media itself - non-linear time has become the dominant temporal figure in 20th century, where the dominant pieces of composition do not causally unfold any more, neither do they end in a harmonic, conflict-resolving *finale* = Fuss 2005. This non-directed linearity, "gestural time" (Kramer), is a semantic equivalent to media-technological *Eigenzeit*

- chrono-entropical directedness of physical (thermodynamical) time becomes "final destination" by the hypothesis of a discursive imaginary called history; *sense* (ital. *senso*) und *end* thus converge asymptotically. The frontispiece of Lafiteau's *Moeurs des sauvages Ameriquains* (FO 1724) "shows the encounter

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15 Here quoted after: Klaus Peter Richter, Zeitfenster des Augenblicks, in: Frankfurter Allgemeine Zeitung No. 128 (4th June 2003, N3)
16 See Martin Ebeling, Verschmelzung und neuronale Autokorrelation als Grundlage einer Konsonanztheorie, Frankfurt/M. et al. (Peter Lang) 2007
17 Jonathan D. Kramer, The Time of Music. New Meanings, new Temporalities, new Listening Strategies, New York (Schirmer) 1988, 20
18 Hans-Ulrich Fuss, Musik als Zeitverlauf. Prozeßorientierte Analyseverfahren in der amerikanischen Musiktheorie, in: Zeitschrift der Gesellschaft für Musiktheorie 2/3 (2005); here quoted from the *online* version
http://www.gmth.de/zeitschrift/artikel/205.aspx (accessed July 2009)

of writing and time in a closed space littered with `vestiges´ coming from both Classical Antiquity and the New World. One holds the pen, the other the scythe, <...> which approach each other without ever touching, asymptotically. History deals with relics which can be seen, and seeks to supply explanations; ancient *things* which have become mute throught the degradation owing to time may to some extent become clearer if we invoke *customs* observed among contemporary savages. This operation needs a locus, which in the eighteenth century is the collection: a technique, which is that of comparison <...> and an author, an historian. <...> Lafiteau <...> betrays the desire to fill all lacunae and generate a new order on the ruins of the paternal tradition" = Annette Lavers (review), on: Michel de Certeau, Writing versus Time, in: Rethinking History, ed. M.-R. Logan / J. F. Logan, New Haven: Yale French Studies 59 (1980), in: History and Theory XXII, 3 / 1985, here: 330 f.

Gaming time

- life not really, but only symbolically organized in *stories*; this sense-giving machinery gets in ekstasy when the end of narrative texts coincides with the expecation of the end of time (a sense of ending).

- traditionally, relation and distribution of linearitäty and non-linearity converges with patterns of narrativity. Narration produces in its classical structure of beginnging, midle and end, a linearly unfolding sequence which hallows for non-linear couplings, differering according to the individual laws of media. While movies represent closed blocks of length, television developed the weekly series and its repetition. With hypertextual media (computer games, and the World Wide Web), non-temporal modes of beginning and end become aquainted: hypertime; point and moment to step almost arbitrary[19]

- when expressed in terms of mathematical theory of graphs, an adventure-computer game is everything which is defined by a beginning and an ending (almost „Homeric narrating", according to Erich Auerbach): everything which happens between point *a* and point *b* – *binary space partitioning*.

"A memory function remembers the same response to the same signal: a counting function counts it different each time" = George Spencer Brown, Laws of Form, xxx, 65. This is non-narrative time in action, replacing *raconter* (in French) by *conter*, disrupturing narrative (German "Er/zählung"). For the first time, in the so-called digital age historiography does not take place on the symbolical level of the phonetic alphabet exclusively, but on the level of electronically embodied alpha-numerics. In binary form the year 2000, f. e., appears as numerical string „11111010000", reminding us not to be seduces by narrative suggestion, but to calculate in discrete states, with the consequence not to tell events intransitively but to count them transitively, quantizing data. The media theorist Lev Manovich (in a chapter of his book *The Language of New Media*) calls this the aestheitcs of data banks, corresponding with a data-archaeological information ascetitics. Beginning and end, in

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19 See Stefan Heidenreich, Bilderströme. Lineare und nichtlineare Relationen zwischen Bildern, in: Kunstforum International Bd. 155 (2001), 243- 248

computing media, are not structured by dramatical structures any more, but by the (equally complex) logic of *count down*.

The temporal defect of Fourier Analysis

- time-critical dilemma involved in the Fourier Analysis of heat conduction; a pulse of heat at the origin would be experienced instantaneously, a quasi-Newtonean *action in distans*. Information propagation can not be faster than the speed of light in vauum within the framework of relativity = entry "Thermal conduction" in the online encyclopedia Wikipedia, accessed September 27, 2013

- Fourier Analysis ideally supposes infinitely extended sine waves as its components with no definite origin or ending, it is not decaying and thus theoretically timeless. But with no beginning and no end, this mathematical model misses the essential feature of "wordliness" which in Heideggerean terms is being-to-death. The frequency information which is the result of a Fourier transform is mathematically precise but on the expense of tempor(e)ality. According to Charles Babbage's *Ninth Bridgewater Treatise*, reverberative traces of any present action continue propagating almost infinitely until entropic equi-distribution is being achieved; the *meta*physics of implicitely *sonic* wave forms (be it acoustic utterances, or water wave propulsions, or earth quakes) is "timeless" in the epistemologic sense of Fourier Analysis. This ontological defect has been remarked by Denis Gabor who developed his model of "acoustical quanta" instead; the temporal defect is nowadays being coped with by the development of a "time-windowed" sectional analysis of a signal event (Wavelets). Gabor's electro-acoustic "grains"[20] quantized the time domain itself.

- chrono-technical defect of Fourier Analysis and its algorithmic embodiment as Fast Fourier Transform evokes an alternative modelling of the physical carriers of information transmission ("tradition") that is invariant toward the erasures of entropic, "historical" time. There is temperature even in the replacement of traditional history of technology by different models of media-temporalities: a short-circuiting between past and present that the mathematical principles of such techno-logics enable by providing an operational link. Whenever we listen to sound from machines which has been previously encoded by FFT, we also share literally *a bit* of that past world "that is actually not past but non-linearly 'here.' This could be seen as a sort of a re-presencing of the past" = Jussi Parikka, introduction to part III *Microtemporal Media*, in: W. E., Digital Memory and the Archive, edited and with an introduction by Jussi Parikka, Minneapolis / London (University of Minnesota Press) 2013, 145, referring to Vivian Sobchak, Afterword: Media Archaeology and Re-presencing the Past, in: Media Archaeology: Approaches, Applications, and Implications (Berkeley: University of California Press, 2011), 323–33

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20 Denis Gabor, Acoustical Quanta and the Theory of Hearing, in: Nature Nr. 4044, 159 (May 1947), 591-594

"Ubiquitous oscillations" *versus* transient phenomena: Signals of ending in electronics

- Henri Bergson's *Matter and Memory*: merging of past with present perceptions in the diagram of a geometrical cone which obviously has been inspired by phonographic recording and its re-enactment by the mechanic (later electro-magnetic) pick-up; superposition of the periodic waves generates a complex signal implying the temporal *aporia* of its Fourier analysis

- 1948 Dennis Gabor criticizes idealism of harmonic Fourier analysis; hypothetically endless and beginningless periodic waves miss the temporal (eventual) implementation of a sound happening in the world, key stroke at piano, transient string play - the moment when an idealized model becomes an event in the real, that is: temporalized world

THE TEMPORAL GAP

The visual alphabet, clocks and numbers vs. electro-acoustic space

- auditory sense "particularly adapted to perceptual anticipation in the detection of time patterns and is often so used; <...> either intensity or rhythm rather than pitch have usually been the modulation employed" = J. D. North, Application of Communication Theory to the Human Operator, 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, 372-389 (386)

- privileged relation between the frequencies of oscillations within the human brain and auditory sound wave perception; See Christian Kaernbach, entry "Echogedächtnis", in: Nicolas Pethse / Jens Ruchatz (eds.), Gedächtnis und Erinnerung. Ein interdisziplinäres Lexikon, Reinbek (rowohlts enzyklopädie) 2001, 132f, referring to N. Cowan, On short and long auditory stores, in: Psychological Bulletin Nr. 96 (1984), 341-370

- not by coincidence but cultural-technologically related to phonetic speech (and more specifically to the vocal alphabet): "Although *periodic sound stimuli* are relatively rare in nature (and sinusoids virtually absent), such stimuli are especially important for humans because of their role in vocal communication, and are thus highly significant" = Purves et al. (ed.), Principles of Cognitive Neuroscience, 2008: 153

With media based on the electro-magnetic field, a redefinition in the hierarchy of the senses of perception takes place: "In the space-time world of electric technology, the older mechanical time begins to feel unacceptable" = ibid.; linear perception replaced by synchronisation - a synaesthetic effect within the temporal regime of perception itself. Is there a "sense" of space, a "sense" of time within humans? This may lead to another dimension of synesthesia different from the classical five modal human senses, enhanced by being coupled to technological agencies. "By electric tapes, synchronization of any

number of different acts can be simultaneous. Thus the mechanical principle of analysis in series has come to an end" = McLuhan 1964: 152

- "shift from a predominantly linear to an acoustic base in communication structure. Lines are disintegrating all around us. The NBC 'Today' show has a one-handed clock that indicates minutes past the hour. Since the program is viewed simultaneously in different time zones, it makes sense to tell the audience, 'It's ten minutes past the hour'" = Schwartz 1974: 9

- "The function of a communicator is to achieve a state of resonance with the person receiving visual and auditory stimuli from television, radio, records, etc. Decoding symbolic forms such as <...> drums, lantern signals, or written words is no longer our most significant problem. They extract meaning from perception in a manner prescribed by the structure of the lanugage, code this meaning symblically, and store it in the brain. But the brain does not store everything in this way. Many of our experiences with electronic media are recorded and stored in the same way that they are perceived. Since they do not undergo a symbolic transformation, the original experience is more directly available to us then it is recalled. Also, since the experience is not stored in a symbolic form, it cannot be retrieved by symbolic cues. It must be evoked by a stimulus that is coded in the same ways as the stored information is coded" = Schwartz 1974: 24

- "This state / of communication is like an electric circuit that is always turned on. The juice is present in the line <...>. Today, there is a nearly constant flow of information at all times. <...> We take in electronically mediated auditory and visual information as part of our life process" = Schwartz 1974: 23 f.

- medium and affect: "We <...> should ask about the effects of television and radio programming. Electronic communication deals primarily with effects. The problem is that no 'grammar' for electronic media effects has been devised. <...>. The patterned auditory and visual information on television or radio is not 'content'. Content is a print term, subject to the truth-falsity issue <sc. Platon, *Phaidros*>. <...> As stimuli, electronically mediated communication cannot be analyzed in the same way as print 'content'" = Schwartz 1974: 19

"The space between phoning from one room in a house to another room in the same house is equivalent to the space between a caller in New York talking to someone in London. In both instances, space has no effect on the flow of information. Similarly, time is no longer relevant when communication takes place at electronic speed" = Schwartz 1974: 23

- critique of the notion of the "audio-visual" as such; asymmetries between the auditive and the visual in signal processing (in sensory perception which means *aisthesis* - and in technical media which means mediaarchaeological operations) in its different temporal configurations and eventalities ("the temporal gap", both in its techno- and neurodynamical significance); synchronization between sensory and signalling pulse trains; neuroscientific vocablulary to describe the cognitive timing processes within the human brain resemble the description of technological tempor(e)alities = working assumption of cybernetic system theory

- neuronal sound-sight mapping coupled to external symbolic operations: "As an intensification and extension of the visual function, the phonetic alphabet diminishes the role of the other senses of sound and touch and taste in any literate culture", Marshall McLuhan wrote 1964 in his classic *Understanding Media*, chap. 9 "The Written Word: An Eye for an Ear", 81-88 (84)

- "Today in the electric age we feel as free to invent nonlineal logics as we do to make non-Euclidian geometries. Even the assembly line, as the method of analytic sequence for mechanizing every kind of making and production, is nowadays yielding to new forms" = McLuhan 1964: 85 - which is the algorithmic (especially recursive functions) in computing

- separation of "figure" and "ground"[21]; with the electric image the ground returned - a stochastic ground; "information" content of a television image?

- Bill Viola, *Information*, USA 1973. Videotape, colour, sound, 30 min. = Fig. in: Wulf Herzogenrath et al. (eds.), TV-Kultur. Das Fernsehen in der Kunst seit 1879, Amsterdam / Dresden (Verl. d. Kunst) 1997, 293

- "A television system capable of sending 26 brightness levels sends in one second the information content of approximately 2400 pages of print", Claude Shannon 1948 as a casual comment on the technological options of electronic coding[22]

- Tony Schwartz, in *The Responsive Chord*: when humans watch TV, their eyes function like ears

- "Time and number are fundamental non-verbal aspects of cognition"[23], located in the brain area that cares about sequential ordering (the number form); around 1980, Meck and Church proposed that time and number are represented by the same representational currency

Asymmetries: rhythms for example

- within human brain, working memory "refers to the maintenance and manipulation of information for brief periods of time" = Purves (ed.) 2008: 341; working memory as defined by Alan Baddeley during the 1970s; three capacity-limited *memory buffers* and a *control system*. Each memory buffer maintains a different kind of representation. The *phonological loop* holds phonological (sound-based) representations, the *visuospatial sketchpad* holds visuospatial representations, and the *episodic buffer*" - like the *register* in the CPU of digital computers - "contains integrated, multimodal representations. Each buffer interacts closely with different long-term memory representations: the phonological loop with language knowledge, the visuospatial with visual semantics, and the episodic buffer with episodic / xxx" = Purves et al. (ed.)

21 McLuhan / Powers 1995, "Das resonierende Intervall", 25-36 (25)
22 Exposé Axel Roch zum Symposium *Claude Shannon und die Medien*, Berlin (Museum für Kommunikation) 3. Juni 2010
23 Dale Purves (ed.), Principles of Cognitive Neuroscience, Sunderland, MA (Sinauer), 4th ed. 2008, 51

2008: 406; remarkably close to the stored-program (working memory) concept of computing in von-Neumann architecture

- symmetry a spatial concept; deprived of the temporal axis; here the equivalent rather: asynchonicity; Aristoxenos' notion of *arhythmia*: cp. asynchronous oscillations of neurons in the human brain

- ear previleged as a substitute organ for the missing "sixth sense" = the temporal sense, inbetween is *kinetics* (movement as temporal intergration of successive spaces); binaural hearing: "Interaural time differences arise because of the distance between th etwo ears. Since the speed of sound is relatively slow <...> there is a <tempo->significant interval between the time a stimulus arrives at one ear and then the other" = Purves (ed.) 2008: 162

- "For a coincidence mechanism to be useful in localizing sound different neurons must be sensitive to different time delays, as suggested by psychologist and auditory physiologist Lloyd Jeffress in 1948

- Michel Chion 1994: "Film transmits visual information by projecting a series of still pictures in rapid succession" <13>. "Following each frame, the screen is black for a nearly equal lenth of time" <14>. "The brain 'sees' motion by registering the current still picture, recalling previous frames, and anticipating future frames that will complete the movements. This differs considerably from visual experience in everyday life, where the eye is bombarded with a continuous stream of information" <14>

Asymmetries between the auditive and the visual

- "What characterizes hearing as such is not that it senses mechanical waves but that it senses the distinctions between mechanical waves; just as what characterizes sight is not the perception of electromagnetic waves but the perception of disctinctions between electromagnetic waves"[24]; close to the Aristotelian definition of time as measurement of movement by numbers, which here is: frequencies; opens the "temporal" audio-visual divide: "For the sense of sight those disctinctions (except for color) are spatial ones; but for the sense of hearing they are mainly temporal. To put it directly: what the sense of hearing hears is essentially time" <ibid.>

- asymmetry within the so-called audio-visual media is disclosed in the filmic genre of "still movies": long shots with quasi-photographic endurance. One can cut out a single frame in a film, copy it and produce a long (seemingly) immobile sequence (in fact, the medium - be it mechanically the cinematograph, be it electronically the video monitor - moves constantly), but the accompanying audio track, cut out of one frame, is a sample in its technical sense which - being reproduced, would rather result in a single impulse. An image (f. e. a portrait) can be visually frozen in the "photo film", but not a spoken word

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24 Fred Turner / Ernst Pöppel, The neural lyre. Poetic meter, the brain, and time, in: Poetry (August 1983), 277-309

- limbic system represents the quasi-medium to translate between the separate senses (by hyper-binding and hyper-connectitivy like in electric "wiring"[25]

- eye specialized on spatial and movement-in-space perception and the ear on micro-temporal processes; different capacities in the *temporal* processing and differentiation. Two auditive stimuli with a difference down to two until five milliseconds can be differentiated, while visual perception needs at least 20 to 30 ms for distinguishing two successive stimuli = Mirjam Schlemmer, Audiovisuelle Wahrnehmung. Die Kongruenz und Ergänzungssituation von Auge und Ohr bei zeitlicher und räumlicher Wahrnehmung, in: de la Motte-Haber / Rötter (Hg.) 2005: 173-184 (173). Inversely, this is equalled by the physical nature of sound and vision itself: while sound proceeds onyl with 340 m/s, light notoriously travels with 3 million meters/sec

- alphanumeric binary data processing, indifferent to the difference of the senses which on the interfaces returns only on the level of formats

- Lee DeForest, The Phonofilm, in: Transactions of the Society of Motion Picture Engineers 16 (1923), 61-75

- film camera fixes the image frames on a photochemical basis, while sound or speech is being recorded by application of the cathode ray tube which "writes" the signal on the carrier (on the basis of Vogt / Engl / Masolle 1921 proposal; achieved by Breusing-Hartel 1930); Manfred von Ardenne, Die Kathodenstrahlröhre und ihre Anwendung in der Schwachstromtechnik, Berlin (Julius Springer) 1933, 343. The audio-visual juncture breaks apart into the physical and the electronic; electronic difference to the audio-visual integration approach. When in sound film, the photo cell is used for reading visual information into sound again, it is the cold eye itself which transforms this without reference to any auditory or visual meaning, just operating on the principles of electro-magnetic induction

- Emanuel Goldmann's *Statistical Machine* on the basis of the photocell decoding of medatadata attached to mircofilmed records; see xxx Buckland

- Cornelius Borck, Blindness, Seeing, and Envisioning Prosthesis: The Optophone between Science, Technology, and Art, in: Dieter Daniels / Barbara U. Schmidt (Hg.), Artists as Inventors. Inventors as Artists, Ostfildern (Hatje Cantz) 2008

- film maker Oskar Fischinger in the early 1930s braught geometric patterns on the sound track of the cinematic celluloid which is the cold media-archaeological gaze on sound. While artists in the 1930s used this device for artistic sound synthesis (notably Lászlo Moholy-Nagy declared *Optofonetik* as the media art of the "Optisch-Kinetischen" and the "Akustisch-Musikalischen"[26]),*vice versa* the cathode ray tube has been used for visualizing

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25 See Lawrence E. Marks, On colored-hearing synesthesia: Cross-modal translations of sensory dimensions (1970s), and Richard E. Cytowic, Synesthesia. A unsion of the senses, 1989
26 See Jan Thoben, entry "Technische Klang-Bild-Transformation", chap. 4: "Gezeichnete Klänge - Das neue Verhältnis zum Ton"

sound; these media components themselves remain indifferent to cultural use = Thoben, entry "Technische Klang-Bild-Transformation"; photocell itself techically allows for actual transformation of image into sound: no synaesthesia, but signal transformation, not sensual, but electrophysical transducing

- basic asymmetry between the auditive and the visual in its different temporalities

- Hermann von Helmholtz, by means of specially developed hight-sensitive chronometrical measuring media, calculates the temporal delay within nerves for incoming signals; the run-time (speed of progagation) of signals in the motoric nerves of a frog counts 24,4 meter/sec. - at the edge of a synchronization problem within humans, when technical audio-visual synchronicity might rather lead to irritation than to pleasure since because of its different physical signal run-times in real nature rather falls apart[27]; a lightning strike is seen more immediate than the accompanying thunder is heard / auditive short wave radio advancement of registering lightning

- protentional sound track on film reels; "Phase Alternating Line" (PAL) in colour television (version Bruch)

- Helmholtz: just because the nerve lines are so short humans mostly do not remark the signal transfer delay and thus get the feeling of being always one step behind presence at all[28]

- to human senses (the binaural system) the auditive signal delay is noticable as temporal gap (the echo effect); optical information is perceived as immediate (the literal speed of light, even though light itself is a frequency event out of the electro-magnetic scpectrum, thus a wave form just like sound)

- "According to Helmholtz´ experiments with human nervous reactions a tenth of a second signifies <...> the threshold separating [Humanities from the Sciences or] experience from measurement. <...> But since operating below the differential thresholds of sensual physiology counts to the possibility conditions of technical media – of film i. e. – the historical apriori of the Humanities is at the same time the physiological apriori or technical media. [The empire of media are the blind spot of the Humanities.] Unaccessible to experience and thereby to understanding in history is, [according to Dilthey,] the real or what only media can register or what only exists in writing but not in narration: the „noise of the battles <...>"[29]

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27 See Uwe Sander, Die "fehlende Halbsekunde", in: Handbuch Medienpädagogik, xxx (Springer) 2008, 290-293 (292)
28 Hermann von Helmholtz, Ueber die Methoden, kleinste Zeittheile zu messen, und ihre Anwendung für physiologische Zwecke, in: Königsberger Naturwissenschaftliche Unterhaltungen 2 (1851), Nr. 2, 169-189 (189)
29 Bernhard Siegert, Life does not count. Technological conditions of the bifurcation between Sciences and Humanities around 1900 (especially Dilthey), typescript from lecture on summer academy of Rathenau Foundation for the History of Science, Berlin, July 1994; in German: Das Leben zählt nicht. Natur- und Geisteswissenschaften bei Dilthey aus mediengeschichtlicher Sicht, in:

A critique of the term and the notion of the "audiovisual"

- Platonic cave metaphor mostly remembered for its pre-cinematic *distpositif*; Plato's remark on the audio event: While the inhabitants of the cave can be betrayed by shadows which they take for the movements of real beings, the sound which enters the case from outside is reflected at the inner wall with echo delay. The slow speed of sound (as compared to the proverbial speed of light) irritates the visually orientated perception; the auditory perception connects to the real, the visual to the imaginary, with the human ears being the substitute for the missing time organ, being much more sensitive to subtle changes in frequency than the eyes are to movement as change

- signal delay manifested in the echo effect Aristotle as well (in *Peri Psyches*) identified the existence of an "inbetween" (to *metyxy*), pre-theoretical term for "media" (as channel, defined by Shannons "Mathematical Theory of Communication")

"Live" is not *live*

- audio perception in humans = mechanical vibration of signal trains translated into neuro-electric impulses which are synthesized in the brain; visual perception = parallel processing of light waves translated in electro-chemical transmitters

- sound happens in time but involves space as well = chapter "Ton versus Bild", in: Christian Doelker, Kulturtechnik Fernsehen. Analyse eines Mediums, Stuttgart (Klett-Cotta) 1991, 185; video image recording born out of sound recording

- while electromagnetic sound recording realized in linear "writing" like the mechanical phonograph, image recording (vido) required a decisive modification of the medium, the rotating magnetic tape writing "head" in oblique, counter-directive way to cheat the temporal axis

Audiovision with Julian Jaynes and with Bill Viola

- message of sound within space is temporality. Once the impression of space is being identified as a function of vibrations (which modern techniques of architectural acoustics pioneered by Wallace Sabine around 1900 perform by impulse-response-measuring), its conception becomes dynamic - starting with Jean-Baptiste Joseph Fourier who declared this in his 1822 *Thérorie analytique de la chaleur*. Temporal reverberations (Fourier uses, in his introduction, a term well acquainted from musicology: "resonance") replace rigid geometrical proportions; such vibrations themselves can be translated into a "geometrical" order of a second degree: frequencies, that is: mathematizable quantities

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Medien. Dreizehn Vorträge zur Medienkultur, ed. Claus Pias, Weimar (VDG) 1999, 161-182

(*spectra*); space becomes temporalized, phenomenogically noticable by the physical nature of refraction - "the beding of soundwaves due to a change in speed as they pass through different media" <Viola 1990: 41> -, of diffraction - "sound turning a corner, when the edge of a barrier generates a new series of waves" <ebd., 42> -, and by reflection - the rebounding of sound waves off a surface. "With multiple surfaces this becomes an echo, and it is then possible to hear one's own voice, possibily multiple in times, as it existed at a previous point in time. One can sing with one's self" <ibid., 42>; change in sound propagation takes place due to diffraction - "sound turning a corner, when the edge of a barrier generates a new series of waves" <ebd., 42> -, and by reflection - the rebounding of sound waves off a surface. "With multiple surfaces this becomes an echo, and it is then possible to hear one's own voice, possibily multiple in times, as it existed at a previous point in time" <ibid., 42>

- propagation of acoustic waves requires a runtime which can even be noticed by the human binaural perception; run time of acoustic signals can be measured by autocorrelation: folding a delayed signal onto its original[30]

- "There is something of the immortal in an echo <...>; we can easily imagine an ultimate state of reverberation - a space where everything that has ever happened continues to exist - the end of time" <Viola 1990: 42; orig.: The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (Hg.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54. First published, in shorter form, in the catalogue for the National Video Festival, Los Angeles (The American Film Institute) 1986

- the auditive (based on wave propagation) is *immanent* to the electronic image. It is a media-inherent logic which in the late 1920s led John Logie Bairds to store electromechanical television lines on gramophone, his *Phonovision* storage system. From television to sound: *Phonovision*

- Léon Scott's *Phonoautographe* kind of "natural stenography" (Jonathan Sterne[31]) indeed - a kind of writing which emancipated from the vocal alphabet to such a degree that by optical scanning it can now be reconstructed as sound information again (like the song "Au claire de la lune") - with the digital processing being the true non-human archaeologist of an auditory event in the past (*audiovision* not as aesthetic phenomenon, but as technomathematical synaesthesia). The original phonautographic curves along the rotating cylinder (the *kymograph*) register the "actual" (that is, temporally authentic) acoustic event, thus being closer to operative Fourier analysis of sound than to cultural articulation

- different from the cinematographic image, the electronic image is close to sound by (time) nature

- visual sense when confronted with electronic images affects the internal "sense" of temporality (as being-in-time) which is otherwise rather located within the auditory sense of perception, different from the durability which is

30 Gottfried Ehrenstrasser, Stochastische Signale und ihre Anwendung, Heidelberg (Hüthig) 1974, 90f
31 Jonathan Sterne, A Machine to Hear for Them: On the Very Possibility of Sound´s Reproduction, in: Cultural Studies Bd. 15, Heft 2 (2001), 259-294 (267)

the message of visual configurations (co-existence of bodies in space, as expressed by Gotthold Ephraim Lessing in 1766 = *Laocoön*): An Essay on the Limits of Painting and Poetry, transl. E. A. McCormick, Indianapolis (Bobbs-Merrill) 1962, esp. chs 16, 20

- time-criticality of lip synchronization in films. A special application of spatio-temporal video warping is dubbing a video with another soundtrack: "The new soundtrack rarely matches the lip motion of the original video, and particularly disturbing are cases when the mouth moves but no sound is heard <...>. The mouth motion can be accelerated or slowed down using an appropriate time flow <...>"[32]

- "In time series analysis, dynamic time warping (DTW) is an algorithm for measuring similarity between two temporal sequences which may vary in time or speed. For instance, similarities in walking patterns could be detected using DTW, even if one person was walking faster than the other, or if there were accelerations and decelerations during the course of an observation. DTW has been applied to temporal sequences of video, audio, and graphics data — indeed, any data which can be turned into a linear sequence can be analyzed with DTW"; partial shape matching application; "sequences are 'warped' non-linearly in the time dimension to determine a measure of their similarity independent of certain non-linear variations in the time dimension"; such sequence alignment method is often used in time series classification = http://en.wikipedia.org, entry Dynamic time warping, accessed August 5, 2014

- acoustic temporality anticipates technical inventions: "If we sense that the description of sympathetic vibration <"resonance"> bears some resemblance to radio broadcast, it is no coincidence, the same principle is at work" = Viola 1990: 42, equiprimordially

Kinaesthetics of the electronic image (with Viola)[33]

- video image, with its divisions into lines and frames, "is a living dynamic energy field, a vibration appearing solid only because it exceeds our ability to discern such fine slices of time" <Viola 1990: 44>[34]

- "As much as the infinitesimal calculus that *pretends* to deal with motion and change by minute fragmentation, the film *does* so by making motion and change into a series of static shots. Print does likewise while pretending to deal with the whole mind in action. Yet film and the stream of consciousness alike

32 Alex Rav-Acha et al., Evolving Time Fronts: Spatio-Temporal Video Warping, http://www.vision.huji.ac.il/videowarping, chap. 4 "Spatially Varying Time Flow"
33 Bill Viola, Der Klang der Ein-Zeilen-Abtastung, in: Theaterschrift 4: The Inner Side of Silence, Brüssel (September 1993), 16-54; orig.: The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (Hg.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54. First published, in shorter form, in the catalogue for the National Video Festival, Los Angeles (The American Film Institute) 1986
34 See as well Maurizio Lazzarato, Video Philosophie, Berlin (b_books) 200x

seemed to provide a deeply desired release from the mechanical world of increasing standardization and uniformity" <McLuhan 1964: 295>

- In 1911 Henri Bergson's *Creative Evolution* associates the thought process with the time-discrete form of the movie

- synthaesthetic transfer (audio-visual metonymy) takes place, when the "video as a virtual image" is being discovered in its "vibrational acoustic character" <Viola 1990: 44>; media-archaeologically true: "Technologically, video has evolved out of sound (the electromagnetic) and its close association with cinema is misledaing since film and its grandparent, the photographic process, are members of a completely different branch of the genealogical tree (the mechanical / chemical)" <ibid.>

- theorem of the electronic image as quasi-phonographic one-line-scanning (with the notable pre-digital difference of the interrupted line jump)

- "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 ibid.> - closer to the electro-chemical transduction within human eyes and ears when communicated to the brain

- frequency-based technologies *resonate* with the human perceptual mode in a privileged way; on the side of media-theoretical analysis (and consequently technological synthesizability) is matched mathematically by the Fourier analysis which applies to periodic signals of almost all kind (continuous and discontinuous)

- "Musicall speaking, the physics of a broadcast is a type of drone. The video image perpetually repeats itself without rest at the same set of frequencies" = Viola 1990: 46. "Western music builds things up" <ibid.>, synthetically. "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 meain musicians even start playing, stated by the presence and countin of the tambura. A tambura is a drone instrument, usually of four or five strings, that, due to the particular construction of its bridge, amplifies the overtone or harmoic series of the indivual notes in each tuned string. It is <...> continually present throughout." <ibid.>

Media of audio-vision: Sound film and music video

- synchronicity between the sound camera and the film camera: this audiovisual harmony is rather counter-naturally (that is: technically) achieved, negentropically, a betrayal of *Gleichzeitigkeit* towards the human temporal perception in multimedia; two chrono-technologies at work within sound film: a) technically enforced synchronization and b) Timecode (since analog-hybrid video days), somewhat corresponding with the "internal clock" mechanism within the human brain and the multimodal sense data integration. What is at work here is *both* the analog (continuous) and the digital (quasi-numeric) regime

What started with mechanic cutting of celluloid as time-order-manipulation *within* the narrative filmic frame (montage), with digital imagery led to complete non-linearity in adressing the content, *explosive time.*[35]

- Eistenstein and Pudowkin opposed sound film (like Rudolf Arnheim in his "Towards a new *Laokoon*"), respectively: sound as conscious counter-rhythm to the images, asynchronical, in order not to create the acoustically "realistic" trap. Silent film remains a "cool" medium like the (early) telephone; synchronized sound turned it into an attention-absorbing medium, audiovisually "hot"

- "live"-Transmission von Television is a betrayal of the temporal gap: there is a minimum delay in electro-magnetic waves which finds its limits at the speed of light; with sound this delay is more critical, since human sense would sense a temporal delay in acoustic waves which travel comparatively slow (330 m/sec.), creating an asymmetry for human senses between the transmission of electromagnetic and of mechanical waves

- what appears as technical failure, turns out to the condition for audio-visual perception within humans: Image and sound should not be exactly synchronous, but slightly delayed. Signals, not at the same time technically expressed, create the impression of same time[36]

From silent movies to film sound

- hyphen both binds and separates the auditive and the visual appears in Michel Chion's Audio-vision. Sound on screen, New York (Columbia University Press) 1990

- due to different signal delay time (*delta-t*), audio track in sound films has to be installed *asynchronically* in relation to the visual frames - a differential time domain. What the sound at a moment of time articulates does not relate to the frame above, but to the next one = Gerhard Schumm, Diagonalmontage und Fotofilm, in: Gusztáv Hámos / Katja Pratschke / Thomas Tode (eds.), Viva Fotofilm. bewegt/unbewegt, Marburg (Schüren) 2010, 151-162 (157), referring to Hollis Framton's film *Nostalgia*, USA 1971

- clear separation (against "audiovisual media") between "audio" and "visual". The one is physical vibration, mechanical impulse, the other refers to the electomagnetic spectrum, a sense organ for "radio" in terms of radiation; ears and eyes are completely different data processors.

Early expriments by Edison's engineer Dickson with coupling a phonograph with cinematograph: synchronization problems.

- by definition, sound film a time-critical medium. With the introduction of the optical film soundtrack in the end 1920s, "the sound is photoelectrically

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35See Michael Rubin, Nonlinear. A guide to digital film and video editing, 3rd ed. Gainesville 1995
36 See Christian Kassung / Olaf Kriseleit, Bild als Medium, xxx 2002

recorded on a narrow track beside the visual images, and the fact that it is visible means that is can even be monitored and analysed. <...> Many of these systems used a principle derived from that of the siren, interrupting the light-beam by a rotating opaque disc in which holes or slits had been cut." <Davies 1994: 6; fig. 7>]

- most of photoelectric organs and organ-like intruments from the late 1920s and the 1930s were based on the mechanism of a rotating disc that interrupted the passage of a beam of light between its source and a photocell <...>, thus avoiding the wear and tear of direct contact with the surface of the recording

- (Video) synthesizers take over synaesthetics, with their time-base correctors.

acoustic signals are functions of one variable only: time[37], whereas images contain two further spatial variables.

Storage of sound is linear (phonographic groove), like a graphic inscription of the time line, wherease cinematograpic movement requires discreet storage in single frames: punctual, "logical" time

The technical synchronisation of two sensorial channels is unprobable, thus negentropic, since when sound and vision is simultaneously recorded (like in the Edison Kinetophon, 1913), re-play (projection) nevertheless needs mechanical coupling; thus synchronisation is forced upon as temporal violence.

- sound film not simply an extension of the silent film, but a new media process = Salm 2010: 3

Only with sound translated into modulated ligh can sonic articulation be inscibed on the movie carrier celluloid "within its own medium". Its media-archaeological condition is the electronic vacuum tube, a media-epistemologically completely different approach, first developed by Ernst Ruhmer (his Photographophon, 1901). The alternating current induced by the microphone is "rhythmically" inscribed as light information on the celluloid analogue to the varying sound amplitude. The key element is the selenium cell.

As cinema, the auditive and the visual break apart both technologically and in human perception.

The eye perceives in discontinuous jumps, while the ear perceives rather linearly. Sound film blends both together.

Since the visual movement is discretely processed and the sound is perceived by human ears continuously, on the storage medium sound and vision must be artificially delayed, deferred, with ca. one second distance between the "sonic" and the relating image.

- cultural prefiguration intervenes: In narrative video-clips the perception integrates audio-visual differences in other ways than for non-narrative video-

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37 See Friedrich Kittler, Optische Medien. Berliner Vorlesung 1999, Berlin (Merve) 2002, 276

clips <Schlemmer 2005: 183>; the affective reaction is different, like the "sonic" as different from the simple physical "acoustic" (Peter Wicke)

- synchronous sound turns mechanical cinema into an "art of time" = Jan Philip Müller, Synchronisation als Ton-Bild-Verhältnis, chap. 5 "Lichtton: An art of time", under: http://beta.see-this-sound.at/kompendium (access July 2010), referring to xxx Chion, L'Audio-vision (1994), 16

... with Chion

- critical difference between the physiological processing of images and sound is in its temporality: "Sound perception and visual perception have their own average pace by their very nature; basically, the ear analyzes, processes, and synthesizes faster than the eye."

Michel Chion's argument re-invents Lessing's basic distinction he makes in his treatise *Laocoon* between the semiotics of the visual arts as compared to the literary arts: "The eye perceives more slowly because it has more to do all at once; it must explore in space as well as follow along in time. The ear isolates a detail of its auditory field and it follows this point or line in time. "So, overall, in a first contact with an audiovisual message, the eye is more spatially adept, and the ear more temporally adept."[38]

- slowness of human visual perception, the "after-image" in retinal perception, as physiological condition of the possibility of perceiving movement where technically there is a fast series of interrupted images in the film projector.

In a chrono-different way this is true for acoustics as well: "This results in a paradox: we don't hear sounds, in the sense of recognizing them, until shortly after we have perceived them. Clap your hands sharply and listen to the resulting sound. Hearing—namely the synthesized apprehension of a small fragment of the auditory event, consigned to memory—will follow the event very closely, it will not be totally simultaneous with it" = 13

"Further, we need to correct the formulation that hearing occurs in continuity. The ear in fact listens in brief slices, and what it perceives and remembers already consists in short syntheses of two or three seconds of the sound as it evolves. However, within these two or three seconds, which are perceived as a gestalt, the ear, or rather the ear-brain system, has minutely and seriously done its / investigation such that its overall report of the event, delivered periodically, is crammed with the precise and specific data that have been gathered" = 12 f.

- "protention" in Edmund Husserl's phenomenology of inner time perception (in addition to Saint Augustin's thoughts on time)

- "Sound endows shots with temporal linearization. In the silent cinema, shots do not always indicate temporal succession, wherein what happens in shot B

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38 Michel Chion, Audio-Vision. Sound on Screen [Frz. Orig. L'Audio-Vision, Paris (Nathan) 1990], ed. and transl. by Claudia Gorbman, foreword Walter Murch, New York / Chicester (Columbia UP) 1994, 11

would necessarily follow what is shown in shot A. But synchronous sound does impose a sense of succession. Third, sound vectorizes or dramatizes shots, orienting them toward a future, a goal, and creation of a feeling of imminence <...>" = Chion 1994: 13

Recall a scene in Ridley Scott's film *Blade Runner* (1982), especially in its "Director's Cut" version:

"By visual microrhythms I mean rapid movements on the image's surface caused by things such as curls of smoke, rain, snowflakes, undulations of the rippled surface of a lake, dunes, and so forth — even the swarming movement of photographic grain itself, when visible. These phenomena create rapid and fluid rhythmic values, instilling a vibrating, trembling temporality in the image itself. <...> It is as if this technique affirms a kind of time proper to sound cinema as a recording of the microstructure of the present" = Chion 1994: 16

"We are indebted to synchronous sound for having made cinema an art of time" <Chion 1994: 16>. An escalation, though, takes place with electronic television.

An electronic device for wilful (technological) synesthesia: the Optophone

- core element of early television is the photosensitive cell which translates light energy into electric current by the photovoltaic effect

- Dadaist Raoul Hausmann developed his *Optophon*; made use of the *Photographophon* as developed by the engineer Ernst Ruhmer 1901 at the Technischen Hochschule in Berlin as a procedure for storing speech signals by light traces (and reverse).

- Hausmann (for signals) anticipating present practices in the data sonification

- Lee DeForest, inventor of the first "electronic", that is: manipulabe vacuum tube (triode) and the "Audion" radio, recalls Ernst Ruhmer's 1906/07 experiments as attempt to photograph sound vibration by means of the *speaking arc*: "Strong telephonic currents from a powerful microphone were superimposed on the direct current across the arc, producing sufficient fluctuations in the arc light to permit a crude photographic record upon a cinematograph film which was driven at a very high speed."[39]

- in a non-linear turn the Optophone did not lead to sound film but to digital computing. This media event is to be described a-historiographically: not "from analog audiovisual aesthetics (and *aisthesis*) to digital calculation", but rather: an abstraction. "The optophone was a <...> apparatus which employed the photosensitivity of a selenium cell for converting light into sound".[40] The presentation of this apparatus led London's *Pall Mall Gazette* to comment that

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39 Lee deForest, The Phonofilm, in: Transact. of the Soc,. of Motion Picture Engineers Nr. 16 (1923, 61- (61)

the new approach interfered with the natural order of the senses and lead to a fundamental irritation of the human perceptual order and separation of time and space on the level of delay time *(Laufzeit)* between sound and light itself: "An ingenious Birmingham scientist has turned the element of selenium to account by making light audible, and we are to be dazzled and deafened both at once. Sunlight makes a roaring sound, and lightening, presumably, anticipates its concomitant thunder. All we require now is to increase the anticipative process, and then day light will awaken us every morning a couple of minutes before it arrives" = June 24, 1912, as quoted in: Borck 2008

- E. E. Fournier d' Albe, The Moon-Element. An Introduction to the Wonders of Selenium, London 1924

- irritation is grounded in the technically induced insight that what seems like a "natural" human order of the senses, its harmonies and disharmonies, is not that natural at all, neither can it be reduced to a changing cultural dimension, but is as well *modulated* by a third world (according to Popper's differentiation), which is artificial nature (signal-recording "analog" and signal-processing "digital" media)

Marshall McLuhan discovered the Optophone as an epistemological device behind the aesthetics of James Joyce's *Finnegans Wake*: as the replacement of the linear typographical regime by electronic acoustic space.

The neurological basis for synesthesia and its electrophysiological detection

- experimental research on perception resulting in different capacities of eye and ear especially in the *temporal* processing and differentiation of stimuli: two auditive "protention stimuli with a difference down to two until five milliseconds can be differentiated, while visual perception needs at least 20 to 30 ms for distinguishing two successive stimuli.[41]

- difference is bio-technical: Differences of pressure in the air are being faster transformed (transduced) into elektrophysiological signals (and transferred to the auditive system in the brain) than the transformation of light in visual impulses happens. The photochemical process on the retina takes longer, as well as the spatial analysis of visual information = ibid., 174

- media-archeological argument: It takes electrophysiological hight-sensitive (vaccum-tube-amplified) measure instruments to detect such phenomena; alliance between the measuring media of brain activity and their essential performance, with both relying on electric events. Only with the advent of the

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40 Cornelius Borck, Blindness, Seeing, and Envisioning Prosthesis: The Optophone between Science, Technology, and Art, in: Dieter Daniels / Barbara U. Schmidt (Hg.), Artists as Inventors. Inventors as Artists, Ostfildern (Hatje Cantz) 2008, xxx-xxx (introduction)
41 Mirjam Schlemmer, Audiovisuelle Wahrnehmung. Die Kongruenz und Ergänzungssituation von Auge und Ohr bei zeitlicher und räumlicher Wahrnehmung, in: de la Motte-Haber / Rötter (Hg.) 2005: 173-184 (173)

vacuum tube amplifier it has been possible to detect smallest electric currents passing through nerves.

- neuroscientist Robert Galambos in the 1930s implanted microelectrodes within single fibers of animal nerve tissue to capture and record electrochemical nerve impulses going from the ear to the brain; here each nerve cell responds to a particula sound frequency of that frequency's absence. "The result was learning the code by which nerves send messages about sound."[42] The phrasing already implies a signal transmission model (in fact: a communication theory) of the auditory perception (the engineering model).

- with Claude Shannon, alliance between brain signal processing and communication media becomes even tighter, since Shannon switched communication engineering from analogue to digtail transmission, with impulses representing the informational unit of a bit and allowing for the "ciphering of the real"[43]. All of the sudden, this coincides with the detection of pulse trains in human signal perception.

For visual perception, Galambos developed the interpretation that the eye sends information to the brain in discrete packets tied to eye movement rather than continuous perception - a supposition articulated since Hermann von Helmholtz.

- experiments with augmenting the visual impression of film by sound = Lee DeForest, The Phonofilm, in: Transactions of the Society of Motion Picture Engineers 16 (1923), 61-75

- neuroscience itself victim to *imaging sciences* / visualizing brain functions; alternatively: sonification of brain waves / neuron oscillations

Is there a specific sense of time?

- extended notion for sensoring: storage, kinesthetics. Within that context, ask if there is a specific sense of time in the human brain, its heterogeneous formation and habituation in and by a culturally and more specifically technomathematically shaped habitat. To an astonishing degree, the neuroscientific vocablulary to describe the cognitive timing processes within the human brain resemble the description of technological tempor(e)alities.

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42 Paraphrase of a comment by Steven A. Hillyard, University of California, San Diego, by Douglas Martin, Robert Galambos, Neuroscientist Who Showed How Bats Navigate, Dies at 96, in: The New York Times, July 18, 2010 (New York edition); *online* http://www.nytimes.com/2010/07/16/science/16galambos.html (accessed July 21, 2010)
43 "Verzifferung des Reellen": Friedrich Kittler, Optische Medien. Berliner Vorlesung 1999, Berlin (Merve) 2002, 320

"The human sense of time operates over many different scales and involves a variety of neural systems. <...> It is not clear whether there is a central internal clock for interval timing."[44]

Some models of interval timing imagine a kind of oscillating mechanism (clock) to be the pacemaker that emits pulses which flow into a neuronal accumulator; "accumulator values are transferred directly into reference memory or via working memory" <Purves et al. (eds.) 2008: 558>.

A less media-mechanic (hinrance clock) model of neuronal interval timing is the triatal-beat frequency model. "This theory also relies on a pacemaker, but it is more biologically realistic in that it depends on the coincidental activation of medium spiny neurons in the basal ganglia driven by neural oscillators in the neocortex" <ibid., 559>.

The privileged sense organ for time perception is binaural hearing: "Interaural time differences arise because of the distance between th etwo ears. Since the speed of sound is relatively slow <...> there is a <tempo->significant interval between the time a stimulus arrives at one ear and then the other" <Purves (ed.) 2008: 162>.

"Neurons in the medial superior olive <...> compute <sic!> the locating of sound stimulus sources by acting as coincidence detectors. The neurons respond most stronly when two inputs arrive siultaneously" <ibid.>.

"For a coincidence mechanisme to be useful in localizing sound different neurons must be senstiive to different time delays, a concept first suggested by psychologist and auditory physiologist Lloyd Jeffress in 1948" = ibid., in the year of Shannon's "A mathematical theory of communication" and Wiener's *Cybernetics*

ANALOGUE-TO-DIGITAL MEDIA THEATRE

"Richard Two Bodies"

- semi-virtual staging of Act IV of Shakespeare´s drama *Richard II* in order to visualize the implicit theory of „the king´s two bodies" with real actors in inter-action with virtual bodies; rehearsal of the „mirror scene" in the studio of the Academy of Media Arts, Cologne, replacing the mirror by a camera which at the same time mirrors Richard´s face and allows for digitally manipulating this face in real time into an anamorphic image (morphing Richard)

Hatsune Miku "on stage"

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44 Dale Purves, Principles of Cognitive Neuroscience, Sunderland, MA (Sinauer) 2008, 51

- "vocaloid" = bodiless voice; real-time virtual actor on stage. Accompanied by an actual live band. Do human musicians, when coupled to a software performance, change from the "live" to the "real time" (digital) mode?

- If such a holographically animated vocaloid is rehearsed on setage in the real presence of a human audience, is such a re-embodied voice perceived in different ways than acousmatic voices from loudspeakers and earphones?

- presentation Hee Seng Kye, Music Research Center, Hanyang University, Koreahskye@hangyang.ac.kr "(Re)sounding the Virtual: Hearing the Voice of Hatsune Miku", conference *Sound Art Matters*, University of Aarhus, June 1-4, 2016; lecture Borbach "Sirenic voices", workshop Jerusalem; Steven Feld, "acoustemology"

Between analog transmission and intelligent coding: "Algorithmic liveness. Editing the audiovisual present" (Marcus Bastos)

- analog wave signal continuously variable along amplitude and frequency; variable "time-object", but no "timestretching" in real time = Harmonizer

- telephony= voice-grade line; acoustic changes in air pressure onto the electro-mechanic transducer; converted into voltage fluctuations; alternating current a transitive analog of the actual voice pattern; frequency band defined by what the ear requires to elicit meaning from ordinary speech; vast majority of sounds that constitute intelligible speech fall between 250Hz and 3,400Hz

- signal moving through a channel loses power and becomes impaired by factors such as moisture in the cable, dirt on a contact; basic amplifier a dumb device. "All it knows how to do is to add power" = Jeff Riddel, Telecommunications Essentials. The Complete Global Source for Communications Fundamentals, Data Networking and the Internet, and Next-Generation Networks; each time a signal goes through an amplifier, it accumulates / amplifies noise as well. Increasing communicational entropy in analog networks: "After you mix together coffee and cream, you can no longer separate them: After you mix the signal and the noise, [...] you end up with very high error rates" = Riddel; instead, digital networks use regenerative repeaters / signal regenerators; digital pulse, like an analog signal, eroded by impairments in the network; repeater "examines the signal to determine what was supposed to be a one and what was supposed to be a zero. The repeater regenerates a new signal to pass on to the next point in the network, in essence eliminating noise"; for analog signal transmission, error rates already measured in bits (1 in 100,000 bits); digital signal transmission with satellite, 1 in 1 billion per second, and with fiber, 1 in 10 trillion bits per second

- digital signal = series of discrete pulses, representing / incorporating "bits"; coding scheme defines what combinations of ones and zeros constitute all the characters in a set which transcends the mere phonetic alphabet: symbolic enactment of mechanic typewriter / teletype (lowercase / uppercase letters, punctuation marks, keyboard control functions); "ones" and "zeros" physically carried through as high voltage or as null or low. In optical networks, bits are represented by the presence / absence of light; on/off conditions

- codec (coder-decoder) converts analog signals into digital pulses; minimize the number of bits per second required to carry voice digitally. In cellular networks limited by available spectrum; compress voice further

- modem (modulator-demodulator) infuses digital data onto transmission facilities; ISDN; manipulate the variables of electromagnetic waves to sufficiently differentiate between binary states

- "digital transmission" = essentially *no more transmission at all*: "Rather than use dumb amplifiers, digital networks use [...] signal regenerators. As a strong, clean, digital pulse travels over a distance, it loses power, similar to an analog signal. [...] But the weakened and impaired signal enters the regenerative repeater, where the repeater examines the signal to determine what was supposed to be a one and what was supposed to be a zero. The repeater regenerates a new signal to pass on to the next point in the network, in essence eliminating noise [...]" = From: Jeff Riddel, Telecommunications Essentials. The Complete Global Source for Communications Fundamentals, Data Networking and the Internet, and Next-Generation Networks; cp. alphabetically coded "transmission" of cultural knowledge = rather "transcoding"; codec (contraction of coder-decoder) converts analog signals into digital signals; modem (contraction of modulator-demodulator) to infuse digital data onto transmission or storage facilities (epigraphs, parchment, paper, wireless telegraphy, radio / TV)

– *On Transmission*. Audiovisual experimental intervention by Marcus Bastos (Sao Paolo), 7th Februar 2017, Humboldt University; true media theatre as both operative analysis and performative questioning of the chrono-techno-logical conditions of the present media condition; *flimmering* and *flickering* present (its analog / digital timing). The apparent *immediacy* (in spite of Maxwell's / Hertz' discovery of its finiteness) of electro-magnetic radio transmission (as long as it can still be experienced in analog reception such as Short Wave Radio); high frequency waves are transduced into the phenomenologically perceivable *latency* of mechanical sound waves; inbetween: the integrative one-line scanning of the electronic TV signal into the (interlaced half-) "image" of a quasi-cinematographic frame. The *micro temporalities of the digital* is explored as fast swapping of present and its very immediate pasts, based on patches for signal delay. Max/MSP provides only for audio buffers. For video, unpack the data to a matrix that could be stored on memory for further handling, but not the video itself; patch configurations with MAX that allow to "see" radio signals events; contrasting moving images "eras" inbetween themselves

- how transmission happens and how it produces the feeling of liveness (technical diagrams of radio, tv and MIDI); artworks use transmission as a medium (Brecht's radio piece *Lindberghflug*; Paik's TV piece *Good Morning Mr. Orwell*

- "lacunar" (Bastos) archaeology of electronic signal transmission: a ring of microphones of different technological generations, chained in a way that they accumulate eventual latencies they might produce, as a device to filter sound and make people aware of transmission's techno-idiosyncracies, and how technical aspects that phenomenologically are considered erroneous can be

media-archaeologically explored and explained in meaningful ways; cp. "acoustic camera" array; microphones as cental non-human agency

- *On Transmission*; divided in one part based on old radio transmitters / microphones from the beginning of the century = the Brechtian universe; other part based on TV sets from the Paik era; a third based on current transmission technologies;

- correlating interplay of transmission / transduction / encoding; signal transmission with the electro-acoustic transducer (the microphone / the loudspeaker, in reverse); "poetics of signal processing" in electro-acoustic systems unfolds = Jonathan Sterne / Tara Rodgers, Poetik der Signalverarbeitung, in: Zeitschrift für Medienwissenschaft vol. 5, no. 2/2011, 122-137; Eleni Ikoniadou, *The Rhythmic Event*, MIT Press 2014; Shintaro Miyazaki's notion of "algorhythmics"; concept of digital "events" not simply the binary sequences of zeros and ones but algorithmic pulsation; cycling units within computers; still not confuse algorithms and rhythms

- If the inscribed phonographic traces on wax cylinders from Edison's days are opto-digitally retraced, inaccessible sound recording becomes audible again; one aspects of old radio transmissions and microphones in exploring in part 1: Short Wave receivers technically from the *past*; *present* reception rather than *pre-set*

- un/precision of term "liveness"; idea of live as a transmission comes from television; a model based on acts in which the "actant" is in front of its audience, as a bodily testimony of the fact that he is doing something "to" the signals — creating this maybe auratic sensation of presence, even on heavily mediated situations such as a pop concert; BA Mai Le, Hatsune Miku; Auslander, *Liveness*

- real time processing creates a completely different situation, of executable occurrences that depend on computing, and specially in computational processes that happen fast enough so that human perceptions takes it as "live"; idea of an algorithmic liveness; real time processing, even if performing it has a certain amount of triggering of events that are previously assembled

- to what degree parts of the *delayscapes* performance presented 7th January, 2017, ACUD Berlin, depend on calculations that render elements on the screen on the fly; how live inputs measuring the pressure of the frequency of sound events as means to chance visual elements; vertical lines that progress on screen "drawn" by sound parameters "heared" in real time by Isadora software — parameter 1 (louder sounds makes thicker lines); parameter 2 (reading of sound frequencies produces a number that distorts the line horizontally with more or less intensity)

- aesthetic appeal of contextual liveness depends on the level of occurrences that are triggered on the fly (or captured from audience reactions)

- real time computations triggering visual elements; every time the result is different, since the pulses will happen as a result of computer performance; a second person onstage could trigger it live, instead of stored presets

- "liveness" here mostly refers to the fact that a number of processes rely on the software "listening" to the soundtrack and using parameters of it to alter visual results; not so much about human, but computational agency; see Steina Vasulka's analog/digital video works like *Violin Power* in the 1970s where "analog computer" (sound synthesizer) directs / distorts the scan lines of video image; Yvonne Spielmann, Video. The reflexive Medium, Cambridge, MA 2008

- "algorithmic liveness" = only apparent oxymoron; explore software capacities to "listen" to sound and generate numbers that can alter visuals; final "Digital Transmission" part: "4 speakers will get the same song (Joy Division's "Transmission") from different online sources and treat it in 2 processes: 1. even speakers will play it, with different buffer patterns. 2. odd speakers will convert it into pulses, and also send its output with different buffer patterns. This will circulate on speakers; people amidst it grasp sound rhytmicalities of machinic perception

THE (ALGO-)RHYTHMISATION OF CULTURAL VALUE: DYNAMIC MEMORY AND MUSEAL RESISTANCE

Non-"museal", operative material media archaeology (MAF, Signal lab)

- material objects in the museum by their very presence resisting the passing of time; Roman inscriptions in the Vatican museum; still able to decipher the letters inscribed in stone, whereas in media culture fast transmission is the most valuable quality, an almost immediate transfer of information; "live" aesthetics of transmission of live radio and live television is now called real time processing; telegraphy; virtue of the museum is different: to undo long time distances, to transfer objects in a time channel of transmission (*alias* tradition, heritage); in re-enacting technological devices, the rather time-invariant techno-logical diagram shines through, against the historical context-dependence; "media tempor(e)alities"; cognitive dissonance: they are past but affect sense of present when in operation

- dilemma of curatorial practices employed in museums of technology; media technologies need to be displayed *in implementation* in order for them to be understood; difference between museum-displayed technologies and the operationalization of technical media in the Fundus; the work of a media archeologist more closely resembles that of an engineer than a historian

- museum appeal depends on the physical evidence, but residual smell of oil in old machines if not cleaned too much reminds of / traces former action

- entropy of the material / decay provides for evidence of one-directional time; physical law of thermo dynamics = a tendency from order to disorder, gives "time" a physical sense; during *Delta-t* of an enduring magnetic video tape, "time" at work in the physical sense; digital copy with no decay; stochatically

defined "information" (mean predictability of bit sequences) can be preserved almost without loss; material entropy (except from "quantizing errors" in the digital copying process) not at work; creates a different sense of time; gap between the culture which is dominated by the experience of entropy in tradition, and digital culture of controlled compression (rather than lossless) transfer

- technological media elements which at first glance look outdated but become retro-avantgarde once being deciphered with media-archaeological eyes and minds - such as a telegraphy apparatus which turns out "digital" *avant la lettre*, by-passing the age of so-called "analog" signal processing media like electric telephone; resist the melancholic impulse which is associated with so-called "dead media"; electric telegraph operates with discrete signal transmission: a code which after an age of AM media (such as radio) returned in unexpected ways. Whereas digital data transmission is much too fast to be perceivable directly to human senses, the classic telegraph "dots and dashes", when connected to an acoustic mechanism, may serve as a way of slowing down, even sonifying the nature of coded signal transmission. Retro-futurism hints at a non-linear relation between past and present media techologies, a short-circuiting of media tempor(e)alities; instead of one media system resulting from another, there sudden re-occurrances; artefacts arranged on the shelves of MAF grouped together according to media-epistemological criteria

- non-functional machines and electronic elements in the MAF challenge for media-didactic analysis; taking machinic elements apart in order to try to reanimate their function a way of media analysis in the strict sense: not restricted to textual interpretation but to diagramatic reading of circuit plans and material hermeneutics (media-archaeological philology). If it comes to source code in the case of ancient computers, take the name of the machine-orientated programing language ASSEMBLY literally and dis- and re-assemble it. The media-ontological definition that a technical apparatus is in existence only when being operative requires at least the effort for re-accessing its material processes - even by simulation or digital emulation; repairing dysfunctional media-archeological artefacts: in most cases the re-animation of valuable technological antiquities (like an early TV set) can, for curatorial reasons, only happen a few times without ruining the original ingredients completely; repair once, repeat many times - by recording the singular event in sound and video; movies attached to the online presentation of the MAF a form of "operative" memory / argument in another, time-able medium than the physical collection

- memory regime of media culture both material and symbolic, both engineering and mathematics; two-faced meaning of *technology*: *techné* on the one hand (impressions of physical hardware) and *lógos* on the other (the logical and mathematical intelligence resulting in software)

- media archaeology with a mathematical cutting edge; archaeology (the science of *arché*) is not about media-historical origins, beginnings / inventions, but the archaic: principal functions / logic / circuit diagram; as well about the "square root" = real numbers, physical frictions; symbolic / real machines

- juxtapose artefacts from telephone technology (an electro-mechanical relay element, a variation of Strowger's Automatic Telephone Exchange or a Manual

Telephone Switchboard) with devices from early electronic computing to demonstate how the hardware to perform discrete numerical operations - nowadays almost exclusively be associated with the digital computer - has been literally transfered from a voice communication technology - just like the vacuum tube which had been invented for amplification of week electric signals but was later "mis-used" in Flipflop circuits of early stored-program computers; hybrid cross-overs define "the mode of existence of technical object" (Gilbert Simondon)

- specifically media-induced ways of "re-presencing" the past: technological ways of re-generating and re-storing time signals; media-archaeological focus on the conditions under which the technological past can "have 'presence' in the present"[45]; escape the romantic orientation "via the insistence on a rigorous attention to matter and machines [...]"[46]

- analogue media archaeological artifacts need to work rather "in principle" (literally "archaeologically") to be studied; computational, that is: programmable media produce digitally coded signals

- study media hardware and their signals by opening them, measuring frequencies, sound outputs, voltages; such technologies unfold in their presence when not looked at as economical, techno-historical, or social (STS) gadgets but as signal processing media

- epistemic curiosity as "first trigger" for re-using old/dead/vintage hardware and software; one can not actually use an "old" medium "historically": from the moment it is turned on it is totally "historical present" (grammatical time different from "imperfect"), in presence. Even if you use your C64 with its old floppy drive and old games you are playing those games now and you are bringing it to function now; term "retro" a figure of time for the "short cut" between the past and the presence = Stefan Höltgen, interviewed by Jussi Parikka, August 29, 2016, *online* xxx

Cultural tradition / transmission in terms of communication theory

- plan Eivind Røssaak: conference in Oslo "Kulturarvteknologier" or "The Technologies of cultural heritage" (from archives to museums and the machines they use to store, retrieve and update sources)

- well-recognized "globalization" of cultural values through web-based media splits "cultural value" into a) material and b) informational commodities. Cultural value has been "residential" in occidental tradition (the classicist museum / eternity value approach); with modernity, this has been mobilized /

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45 Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333 (323)
46 Goddard 2014, 13

liquified. Coupled to electronics (a) and information theory (b) no more matter nor energy

- engineering definition of (tele-)communication counts for the mechanism of cultural tradition as well: "The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point."[47]

According to Shannon the *channel* in communication engineering is „the medium used to transmit the signal from transmitter to reveiver" <in: Shannon / Weaver 1963: 34>, involving all kind of side-effects, all the unintended patterns and changes; its cultural equivalent is "tradition". Noise has been excluded as cultural value for long times; media-archaeology uncovers a *mémoire involontaire* of recordings from the past which was not intended for tradition - a noisy memory, unaccessable for alphabetic or other symbolic writing. This becomes most apparent in acoustic records themselves. Listening to ancient phonograms, there is always as well the scratching, the noise of the recording apparatus. True media archaeology starts here: The phonograph as media artefact does not only preserve the memory of cultural semantics but past *technical* knowledge as well, a kind of frozen media knowldege embodied in engineering and waiting to be un-revealed by media-archaeological consciousness.

- cultural heritage in times of communication media: model of techno-cultural "memetics" where cultural knowledge is transmitted by gene-like entities called "memes" which can be either

1 : an idea, belief or belief system, or pattern of behavior that spreads throughout a culture either vertically by cultural inheritance (as by parents to children) or horizontally by cultural acquisition (as by peers, information media, and entertainment media)

2 : a pervasive thought or thought pattern that replicates itself via cultural means; a parasitic code, a virus of the mind especially contagious to children and the impressionable

3 : the fundamental unit of information, analogous to the gene in emerging evolutionary theory of culture

- meme pool (n.) : all memes of a culture or individual
- memetic (adj.) : relating to memes
- memetics (n.) : the study of memes

4 : in blogspeak, an idea that is spread from blog to blog

5 : an internet information generator, especially of random or contentless information
http://www.urbandictionary.com/define.php?term=meme

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47 Shannon / Weaver, The Mathematical Theory of Communication (1949), 31

"Cultural value" and the sense of time

- Instead of traditional endurance, "changing values" is the the signature of modernity. The drama of modernity is the much-lamented dislocation of enduring values by permanent change - which, in terms of Henri Bergson, is the true nature of time. Bergson always insisted "there is no other thing in time than change itself"[48] - which is still an analog notion of continuous time. The opposite is true for the sense of time in digital culture which is structured by non-linear, hyper-temporal access to virtual worlds by discrete addressability (the nature of archival data administration).

- value parameter "historical tradition" or "cultural heritage" under attack, to be replaced by recording presence in real-time, respective re-presencing the memory at an instant, as in photography services like Instagram. While the traditionally rather immobile archive literally gets "in motion"[49], digital culture itself is based on radical temporalization in its most technical sense, since its operations take place in a time-critical window of the present, with the volatility in electric communication where storage media themselves become "dynamic" (RAM) which require refresh cycles

- "When engineers talk about a computer´s `memory´ they really don´t mean a computer´s memory, they refer to devices, or systems of devices, for recording electric signals which when needed for further manipulations can be layed back again. Hence, these devices are stores, or storage systems, with the characteristic of all stores, nameley, the conservation of quality of that which is storede at one time, and then is retrieved at a later time. The content of these stores is a record <...>. <...> `memory´ is a misleading metaphor for recording devices <...>. Of course, these systems do not store information, they store books, tapes, microfiche or other sorts of documents <...> which only if looked upon by a human mind may vield the desired information. <...> By confusing *vehicles* for potential information with *information*, one puts again the problem of cognition nicely into one´s blind spot of intellectual vision <...>."[50]

- GPS; "real time of ubiquity and instantaneity, <...> less physical than microphysical"[51]

- Today, in a networked world, money moves from place to place as data, invisibly, across wires and satellites and as light impulses on fiberoptic cable. Money moves at the speed of light

- One dimension of the global economy is the nearly instantaneous movement

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48 As recalled by P. Janet, L´Evolution de la Mémoire et de la Notion du Temps, Paris (Chahine) 1928, 28

49 See Eivind Rossaak, xxx

50 Heinz von Förster, Thoughts and Notes on Cognition, in: Paul L. Garvin (ed.), Cognition: A Multiple View, New York / Washington (Spartan Books) 1970, 25-48 (29f)

51 Paul Virilio, L´écran du désert, zitiert nach: Laura Kurgan, You Are Here: Information Drift, in: assemblage 25 (1995, MIT), 15-43 (28)

of money across national borders and around the world

- where relative value of currencies changes from moment to moment, exact time stampf of when the money moves is of paramount importance. The disappearance of time by instantaneity

- universally recognized temporal grid - the clock - allows transactions to occur in a common virtual space regardless of geography

- temporalization of value: cp. high-frequency trading at stock market (started with stock market ticker; Lit.: Alex Preda); "optonism", derivatives

- essence of the temporal economy of tele-communication is capitalist chrono-logics, as remarked by Karl Marx in 1857: "[...] while capital must on one side strive to tear down every spatial barrier to intercourse, i. e. to exchange, and coinquer the whole earth for its market, it strives on the other side to annihilate this space with time, e. e. to reduce to a minimum the time spent in motin from one place to another."[52]

- The "frequency domain" of what is the "time domain" in telecommunicative signal transmission is the capitalist value it can be measured by: A Depesche in the Indo-European Telegraph Co. line between London and Kalkutta (opened 1870) took between half and one hour and was exactly payed in Swiss Frank (the then international currency) for each telegram (87,5 Wwiss Franks per Depesche), with around 200 telegrams per day.

- *streaming*. "Our candidate for replacing the desktop is called `Lifestreams´."[53] "Every time you use a creative work in a digital context, the technology is making a copy"[54]; there is no more entropic time inbetween original and copy. The singularity and endurance of the traditional work of art is being replaced by ephemerality and logical (rather than Benjamin's analog) reproduction as co-originary recreation. The material embodiment (which is still required) itself becomes transitory, a function of algorithmical computing.

Not yet memory? Intermediary storage, delay lines

- first British fully electronic computer, developed in 1949 and engineered by Wilkes, Wheeler and Gill, called EDSAC = Delay Storage Automatic Calculator

- new temporality of cultural value, its (algo-)rhythmization, becomes transparent in the inner life of computing and communication engineering: a

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52 Karl Marx, Grundrisse. Foundatins of the Critique of Political Economy (Rough Draft), Harmondsworth (Penguin) 1973, 538 f. See Roland Wenzelhuemer, Globalization, Communication and the Concept of Space in Global History, in: Historical Social Research, vol. 35, No. 1 (2010), 19-47

53 David Gelernter, Machine Beauty. Elegance and the Heart of Technology, New York (Basic Books) 1997, 102

54 Lawrence Lessig, Remix. Making Art and Commerce Thrive in the Hybrid Economy, London (Bloomsbury Academic) 2008, 98

delicate system of "sampling" presence and its mathematical processing which consists of ultra-short moments of intermediary storage (the "registers" in the Central Processing Unit of micro-processors) and volatile "dynamic" short-time storage (RAM chips), or by intermediary calculation (predictive algorithms) in massive data transfer (digital tele-communication)

Resisting acceleration: the *katechontic* function of archives and museums

- position of the museum as a beholder of cultural materiality against the backdrop of digital acceleration. How can a museum position itself within "the time-critical window of the operative present"? storage value is subject to ever shrinking "endurance". The museum, whose primary functions are to store and preserve can only resist to this accelerated time when staying off-line, thereby suspended from immediate consumption.

- entropy manifest in what cultural heritage knows as irreversible loss in tradition, analogous to the arrow of time in the second law of thermodynamics. To slow down this entropy: cultural islands of order like the archive, the library, and the museum, as neg-entropic resistance against *chronos* ; with a heavy amount of energy, order is maintained there for an interval, might extend to millenia

- Against the physical tendency of matter to dissolve into disorder, culture operates by creating and maintaining literally un-natural orderly states. For Christian theology, the New Testament (the letters of apostle Paul), *katechon* is the term for delaying the return of the Anti-Christ, that is: the end of the world (later to justify the political order of the Roman empire and other institutions)

- archivological "Sperrfrist", that is: logical (symbolical) or physical (*off-line*) dis-connection from immediate access. "Siegecraft, once the art of defending the strategic cities of European states, has become the art of defending the archive" = Richards 1992: 124 f. "Die Festungen *schützen Raum* und *gewinnen Zeit* [...]" = E. v. H., Die Festungen in der modernen Kriegsführung, in: Im Neuen Reich, vol. 1 (1871), 53; § "Agencies of cultural feedback: the infrastructure of memory (the archive)" = WASTE; Michael Thompson, Rubbish Theory. The creation and destruction of value, Oxford UP 1979

- channel of transmission as explicit *medium* central to the Shannon diagram of communication; storage function is not expressed, rather implicit in act of encoding / compression. In reverse, the museum (like the archival record) is emblematic for the exclusive storage function: "For of the three functions of a Universal Discrete Machine (storage, transfer, and processing of input data) two functions, transfer and processing, are omitted in a museum. Nothing must be changed in things that are preserved [...]" = Kittler 1997: 69

- "temporally" suspending the channel of transmission, just like the book-printed text suspends the channel of transmission by becoming a frozen medium itself. The essence of the museum is its storage function, to except cultural values from the economical circulation: a literally *ana-chronistic* medium.

- archaeology no longer snatching past cultural values from the soil for supplying museum store-rooms; nowadays industrial and rubbish-archaeology analyses the present in real-time[55]

- indicative of the digital condition that the traditional material object is now expressed by a term which is already derived from computer graphics and the digital architecture of n-dimensional mathematical space: the "3-D object"; strategic advice for museums is counter-resistance against virtual worlds. the material object in its incalculable contingencies, physical endurance and multi-modal interactions with human sensation - Benjamin's *aura* - can not easily be maintained by conversion into digital registers

The new role of the museum (object)

- "Für prozessuale künstlerische Interventionen im Internet gibt es <...> keine Archivierungsform mehr"[56]; shift of emphasis from fixation to transmission of cultural value

- the museum becomes a katechontic institution of materialities against the ephemerality of data in Cyberspace

- between memory and erasure, cultural memory not located in separate or even secret institutions like the museum and the archive any more, but literally *online* coupled to permanent feedback in present discourse as negotiation: ckultmat-lager / *Feedback*, the sender's monitoring and adaptation of his or her own message by observation of its effects on the recipients, became a key term of systems theoretic communication theory <...>. *Negative feedback* influences the sender to correct or change the message because of observed undesired effects. It thus contributes to communicative homeostasis, the maintenance of a steady state. *Positive feedback* reinforces existing structures of the message.[57]

- museum not the terminal for parcel post from history, art and culture any more. Instead the museum becomes a flow-through and transformer station, a relay. Its task now is mobilizing, defreezing the accumulation of objects and images in its repositories, making them accessible to the public by displaying the stacks or recycling them into the exhibition area. This corresponds to the fleeting character of the past in electronic memory: Point of light on the screen flash past as expressed by Walter Benjamin when in his essay *Über den Begriff der Geschichte* he wrote that the past can onlybe recorded as an image which simply flashesthrough one´s mind at the moment ofits dicernibilitynever tobe seen again; architectural memory of museums is liquefying. Mnemosyne might have been the mother of the muses; the museum though is not concerned with

55 See Italo Calvino´s description of xxx in: Invisible Cities, xxx
56 Hans Ulrich Reck, Metamorphosen der Archive / Probleme digitaler Erinnerung, in: Götz-Lothar Darsow (Hg.), Metamorphosen. Gedächtnismedien im Computerzeitalter, Stuttgart-Bad Cannstatt (frommann-holzboog) 2000, 195-237 (203)
57 Winfried Nöth, Handbook of Semiotics, Stuttgart 1990, 178

memory in temporal terms any more, transforming from a final, virtually eternal storage place of cultural heritage to a contaner, a kind of interim store (analogous to the language of nuclear disposal technology)

- radical transformation of the relation of the object to time and space, owing to a semiosis which turns materialites and corporealities into immaterialities and pure information. In the age of the disintegration of the terms of space and time by speed (Paul Virilio), of the advancing immaterialising of information and its being caught up by recording systems in real-time, „other places" like the museum (Michel Foucault ---) become nostralgic retro-effects.

If culture is defined by is memory capacities (Lotman / Upenskij), then the growing predominance of <ZWISCHENLAGER> contributes to a radical transformation of the economy of history. The ideal of accumulation ...

- financial capital strives for minimizing the temporal lenght of storage (which then is „dead capital"); the supply system of the Benetton company virtally programs its storage time to zero by a supply-demand-relationship aiming at real-time. Eletronic random access to the stores turn memory into omnipresence of commodities. What looks like a by-product of this recycling is in fact the establishment of a new *epistemé*: the standardisation of knowledge (technically hidden, while producing a cult of cultural difference on the surface).

"Museums on the Digital Frontier": An *updating* of Kittler's approach

Friedrich Kittler, Museums on the Digital Frontier, published in: Thomas Keenan (ed.), The End(s) of the Museum, Barcelona (Fundació Antoni Tàpies) 1996, 67-80

Museum in digital culture does not simply mean computer-augmented museum space, "focusing on the multimedia dream of making things more user-friendly" (Kittler). In reverse, virtual reality allows "to enter the architecture of digital media" = Kittler 1996: 77. The von-Neumann architecture of computing replaces traditional museum architecture. Navigating the computer from within: Virtual reality allows for making visible hard- and software; still, an observational second-order-observation paradox (as expressed by Heinz von foerster) arises. The computer - even if it absorbs all other previous agencies of cultural memory - can not itself be displayed from within - unless in real-time emulation: "The computer medium can archive all other media but not iself" = Kittler 1996: 78

- "Computer museums <...> would have to store state diagrams [...], hardware architectures and software solutions - and store them so precisely as to preserve at least the validity of mathematical algorithms" <ibid.>. But in order to preserve the cultural memory not simply of the technics and logics of the computer but actual *computing*, this has to happen in an executable way - beyond the *stasis* of traditional archival records.

- the contemporary "museum of algorithms" is Github, "one of the largest dynamic repositories of software online, can be seen to operate as a mode of archive which in turn re-engineers the question of what an archive is. [...] Github is a place where software is stored online and from which it can often be downloaded. More expansively, it provides a sense of the archive as simultaneously a site of fine-grained analysis and of incoherence, of storage and of production. To get to Github, we need to start with Git, a 'source code management' (SCM) system designed by Linus Torvalds in 2005. 1 Git was initially based on the characteristics of a file storage system familiar to its author as the initiator of the Linux aspect of the GNU/Linux operating system."[58]

Kittler's 1996 lecture at Barcelona has become a self-fulling prophecy: challenge of archival preservation / emulation of his source codes within a functional operating system / server structure; ARCTEC-NACHLASS; project *Museum of Algorithms* (Christiane zu Salm); "AlgorithMUS"

Digitally interfacing the museum from within: new options of sorting images

Rijksstudio = developed by the Media Lab at the Rijksmuseum Amsterdam to become one's own virtual curator[59]; and Tate Britain, initiative *Tate Collective*, funded by the xxx Foundation: In a middle gallery room, experimental space for virtual sorting of images, experimenting with other forms of hanging alternative to e. g. St. Petersburg hang; connecting to youth experience in current media culture: web photo, text and video microblogging platform like www.tumblr.com>

<- but Tate Gallery itself otherwise proudly has returned to the historical hanging in its new exhibition 500 Years of British Art>

complex game of finding and relating objects to each other with the possible use of 200 000 objects – but must be a problem with copyrights when it comes to contemporary art

- analytic and critial "pixelisation" of museum paintings like Gustav Klimt (in the work of the Georgian media artist Tea Nili) or Damien Hustinx' work (in the current exhibition Pixels of Paradise, in Paris, until March 2015)

["The Virtual Curator: multimedia technologies and the roles of museums" (Beardon / Worden)]

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58 Matthew Fuller, Andrew Goffey, Adrian Mackenzie, Richard Mills, and Stuart Sharples, Big Diff, Granularity, Incoherence, and Production in the Github Software Repository, in: Memory in Motion. Archives, Technology, and the Social, ed. by Ina Blom, Trond Lundemo, and Eivind Røssaak, Amsterdam (AUP) 2017, 87-102 (87)
59 https://www.rijksmuseum.nl/en/rijksstudio

Colin Beardon and Suzette Worden, *The Virtual Curator: multimedia technologies and the roles of museums*; project carried out in the Rediffusion Simulation Research Center
Faculty of Art, Design & Humanities
University of Brighton
http://www.cs.waikato.ac.nz/oldcontent/cbeardon/papers/9506.html
Zugriff 27. März 2015

paper published in: E.Barrett & M.Redmond (eds.) *Culture, Technology, Interpretation: the Challenge of Multimedia*, MIT Press, Camb, Mass. 1995

museum should concentrate on the material object. Once digitized, the museum object becomes a "metaphor" indeed: transmission (like tele-photography in nineteenth century)

"<...> providing a creative role which stresses the power the student can have as an author rather than as an operator who simply retrieves information or selects between predetermined routes."

"Because of its immediacy, the separation of form and content within a multimedia presentation is by no means clear."

Indeed, as a digital item, the difference between physical materiality and form collapses into digital formats.

no pre-classified exhibition in which the user can only passively select one of a limited number of paths; the unclassified store room

TEMPERATURE DEGREE ZERO: "COLD" STORAGE

Very Low Frequencies: The temporality of Arctic temperature

- radio-active waste is physically treated in terms of "half lives", that is: slow decay of energetic states

Geological temporality is slow motion; its almost immobile memory is time-critical in a long-time meaning: not perceivable by human ("historic") time sensation. Polar ice is a function of long-time climate change which takes place in macro-temporal oscillations; cooling of the earth temperature leads to increasing galciers, heating in reverse to their melting into water. Such a periodicity differs from historical time in that there is no evident unidirectional arrow of time (progress, evolution) involved - no teleology.

While research on global climate change is based on long-time measured time series, meteorology aims at short-time prediction - which in a "memoryless", almost ergodic atmosphere is a challenge for discrete hydrodynamic computation; from time domain (continuous "temperature") to frequency domain (discontinuous data "clouds")

Listening to entropy: "On Speed" (Christian Blom)

- Christian Blom, practice-based researcher at the Norwegian Academy of Music: his work *On Speed* is composed with crystalizations of water, "almost controlling it" = e-mail communication 16 December, 2016. A computer controlled machine runs thermo electric cooling to do the process. "Crystals explode at first, forming a basic shape, and then they grow extremely slow - at the rate of falling water molecules. And this is too slow for us to identify without the aid of memory." Tempor(e)alities unfold when the work is "stretching from 50Hz in the wall socket to the rate of falling water molecules"

- "*On Speed* stretches out in its full temporal specter. Tempor(e)alities places tempo and rhythms at the core of the work, disregards my sensory system and lets the machine be a rhythm machine on its own terms" (Blom)

- two different tempor(e)alities in perception and memory, one is sensed and the other is recollected. "With tempor(e)alities understood as the *micro drama of of temporal realitites* in the computer and electricity the work also stretches down from the frozen water and into the socket in the wall. Out of this socket comes alternating current at 50 Hz, that is 50 cycles per second, the computer runs at 2,3 GHz and the clockspeed of the micro-controller is 16 Mhz. These simple terms, the gigas and megas, hide amazingly fast rhythms. A MHz is 1 000 000 cycles per second and a GHz is 1 000 000 000 cycles per second, a superfast poly – rhythm is playing under the hood of *On Speed.* If we add that the computer asks the microcontroller *what´s the temperature* at yet another rate and in my patch I have clocks ticking at 1 Hz, buffers storing sets of instructions and so forth, *On Speed* displays a variety of tempor(e)alities from 1 000 000 000 cycles per second to a crystal growing at the rate of falling water molecules in the given room. In both ends of this scale of *speeds* the work extends beyond my senses. The concept of tempor(e)alities doubles the power with which *On Speed* tells us something about the discrepancy between what we experience and what is really going on, a nice reminder of our narrow field of perception."

- *On Speed* as epistemic work un-covers hidden processual knowledge which is implicit in matter combined with technical media. By letting a process happen which is not immediately accessible to the human senses is truly "process-oriented ontology". The rhythms and tempor(e)alities which unfold within this physical/logical combination comes close to the *chronopoetics* within the machine. There are oscillations which can not be received by the human ears but rather represent the "implicit sonicity" of technical timings (*Sonic Time Machines*). Beyond (or below) the acoustic "content", the real "message" of such processuality is its time-figures (in McLuhanesque terms). The ice crystalls correspond to what Chladni, in his *Akustik* around 1800, made visible: the "Klangfiguren". In ancient Greek music theory, Aristoxenos (in his fragment on *Rhythm*) coined the term "chronoi" (times, in the plural) for such sonic articulations in micro-time

Chrono-photographic freezing

- Robert Scott and his men "succumbed in the snow of the Antarctic, but the films they made survived" <cfp>

- "Im Speicherzustand erreicht die 'aufgenommene' Information gewissermaßen statische Eigenschaften, die verschiedentlich auch durch die Bezeichnung 'eingefrorene Information' charakterisiert werden."[60]

- compare the photographic moment, i. e. the fixation of a moment in time, to the immediate transmission of an electronic image in television or video. In the first case the photonic event is chemically made to have a lasting effect, whereas in the latter case it vanishes from the phosphor screen of the monitor in a fraction of a second. But even this fraction is an interval, a Δt (even if it tends to zero). The media archaeology of photography itself reveals how the long-time, almost painterly exposure of early Daguerreotypes and Talbotypes by progressing mechanical and chemical means shrinked down to the notable photographic "click" or "shot". On the other hand, it can happen that a photographic negative film is being developed months or even years later, such as in the tragic case when two rolls of film were found next to the corpse of Robert Falcon Scott who died with his team on the way back from the South Pole in 1912 after having only been second to Roald Amundsen. The author of *The Great White South*, Herbert Ponting, a photographer and who previously had accompanied Scott in the Antarctic, had the film developed (= signal memory), while a letter (= symbolic memory) which Scott had found in Amundsen's former tent at the South Pole and carried with him until his untimely death, was uncovered from snow (the medium of oblivion and frozen memory) as well and finally posted to its adressed destination: H. M. King Haakon of Norway.[61] The timing of photographic immediacy and postal deferral, otherwise clearly alternative to each other in its temprality, here interfere, being subverted upside down. Scott from the developed photography still looks at us (the Barthesian *punctum*) as if it was a live transmission, televised from the past - chronotelevision, cutting short and undermining what is cognitively (*studium*) known to us as the historical distance which separates us from that past moment, based on the symbolic regime of historiography (letters)[62]

The "cold gaze": Media archaeology in alliance with the photography

"Freezing" the moment is in alliance with the "cold gaze". This is a media-archaeological truism: In its incubation phase, photography demanded long-time-exposure which made fossils and sculptures its favourite objects - until the escalation into the photograhic "click" turned photographical time upside down - from slow to fast negentropy.

Ernst Jünger saw the camera lens as capable of freezing the moment of danger which enframed traumatic shock in a manageable format. For Jünger, optical

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60 Christian Koristka, Magnettonaufzeichnungen und kriminalistische Praxis, Berlin (Ost) (Ministerium des Innern, Publikationabteilung) 1968, 24
61 See "Letter from the South Pole", in: Living Memory, Oslo (National Library of Norway) 2006, 67
62 Vigdis Moe Skarstein / Tinje Grave 2006: 67

technology creates an almost Nietzschean aesthetic of detachment [...]; thus the photograph "<...> stands outside the realm of sensibility. It has something of a telescopic quality: one can tell that the object photographed was seen by an insensitive and invulnerable eye. The eye registers equally well a bullet in midair or the moments in which a man is torn apart by an explosion"[63] = chronophotographical indifference; photographic and cinematographic "freeze" images corresponds with the literally *theoretical* "cool" archaeological gaze

- "frozen" condition is not just a physical state but a theoretical aesthetic in itself; corresponds with the photographic "shot", the *freezing* of its moving object in a temporal slice / moment

- A medium, unless in operation (under current), is in a cold state of latency

- insistence on the mechanical or electronic or algorithmic "eye", the cold gaze, key to media archaeological approach; a "vision" of machinic agency; before a cultural historian tells stories about past media cultures, there is a prior level on which the past has been recorded; documents of the past are concrete instances of pasts-present, but even more so the way in which technical media records time and acts as a time-machine between current times and the past. This time-machine is non-hermeneutic; already Kittler's claim: technical media do not record only meanings, but also noise, and the physicality of the world much outside our human intentions or signifying structures; for instance an old phonograph is the first media archaeologist before human intervention

- "Media archaeology executed through the epistemological figure of the 'cold gaze' is [...] a way of stepping outside a human perspective to the media epistemologically objective mode of registering the world outside human centred sensory perception."[64]

- thermodynamic indexicality of photography (and film) is rooted in both the heat moment (sudden exposure, light flash), and in "cold memory": in the freezing of the fixed image, preferably in icy conditions, for long time storage purposes

TEMPERATURES OF CULTURAL TRADITION: ENTROPY INSTEAD OF "TIME"

Data-entropy, energy, information

- Entropy in the second law of thermodynamics states that the energy disorder of any closed system tends to increase and points to an uniform equilibrium.

- "Die thermodynamische [...] Theorie der Sprache beginnt im Zustand des

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63 Ernst Jünger, Photography and the second consciousness, excerpt from: same author, On Pain, in: Photography in the Modern Era: European Documents and Critical Writings, 1913 / 1940, ed. C. Philips, New York (Aperture) 1989, 207-210 (208)
64 Jussi Parikka, Archival Media Theory: An Introduction to Wolfgang Ernst's Media Archaeology, in: W. E., Digital Memory and the Archive, xxx, 1-21 (11)

Rauschens."[65]

- "Even our natural languages are made up of discrete , finite elements so that one could argue that all descriptions of continuous processes must be representable in some form by a finite discrete sequence of finite elements."[66]

- a "cloudy" reading of art historical paintings: Rudolf Arnheim, Entropy and Art. An Essay on Disorder and Order, Berkeley / Los Angeles / London (University of California Press) 1971

"The concept of information applies not to the individual messages (as the concept of meaning would), but rather to the situation as a whole."[67] By the very *minus* operator in Shannon's formula, the resulting entropy will always be positive but induced the mis-understanding term *neg-entropic*.

- Markov chain analysis replaces emphatic historicity by "flat historicity": When the probability of a chain of strings from a finite alphabet to turn up in a discrete sequence is dependent on its immediate predecessor. In turn this has effect on time-critical, media-economic techno-mathematical communication engineering (Claude Shannon) - a kind of intelligence which machinically operates both within minds *embodied* in humans and *implemented* in machines. The real drama which unfolds within the technological transmission (channel) and processing is are rather time-logical than culturally contextual; for an analysis of what "actually happens" (Ranke) in that *epoché*, cultural semantics transforms into shere signal-to-noise ratio

In order to preserve digital memory for ages, it is advised to put devices like the USB stick in the refrigerator. Kryonics refers to the inverse Arrhenius equation: the speed of chemical reactions within the very materiality of electronic devices decreases with temperature. Quantum computing (with its elementary qbits) requires extreme cooling to mainain its fragile coherence.

- with thermodynamic "heat death" (Flammarion), the past is "forgotten"; there is even no more time itself

- any transformation of entropic states into improbable information negentropic. Maxwell's demon may be equipped with a torch.[68] This introduces a momentum of feed-back into the circle between entropy, information and negentropy. What once arose as a diagrammatic thought experiment (Maxwell's "demon") has been actually tested in the laboratory. "The sense of sight provides the means for controlling entropy without itself being subject to

65 Hans-Christian von Herrmann, Informationsästhetik, in: Barbara Büscher / same author / Christoph Hoffmann (eds.), Ästhetik als Programm. Max Bense: Daten und Streuungen, Berlin 2004 (= Kaleidoskopien. Medien - Wissen - Performance, vol. 5), 81
66 Pattee 1974: 130
67 Warren Weaver, in: Claude E. Shannon / same author, The Mathematical Theory of Communication (1948/1949), Urbana / Chicago (University of Illinois Press) 1998, 9
68 See L. Brillouin, Maxwell's Demon Cannot Operate. Information and Entropy, in: Journal of Applied Physics, vol. 22, no. 3 / 1951, 334-337

the entropic process. <...> no fluctuation such as radiation interferes with the visual field, and the light that strikes the demon´s eye does not share in the entropic properties of mechanical motion itself."[69]

- in physical science, entropy names the tendency of element distribution in closed systems to become less and less organized, providing time with its "arrow"[70] in accordance with the Second Law of Themodynamics. On the contrary, the informational state is based on Maxwell's" negentropic" demon: intelligent selection (equalling archival "Kassation", *triage*), thereby increasing the "temperature" of two separated thermic systems, resulting from an observational decision, opening / closing a "door" (be it an electromagnetic relay or an electronic flipflop) with the measuring unit *bit*.

- in 1948, Claude Shannon draws connection between the mathematics of communication channel capacities (its signal-to-noise ratio), and the earliers theories of entropy as developed by Clausius and Ludwig Bolzmann

"The entropy is a statistical parameter which measures <...> how much information is produced on the average for each letter of a text in the language. If the language is translated into binary digits (0 or 1) in the most efficient way, the entropy H is the average number of binary digits required per letter of the original language."[71]

- after centuries of philosophical speculation about the nature of time, entropy as defined by Rudolf Clausius and William Thompson in 19th century gave time its physical direction ("arrow") at all. A physical, energetic process is subject to the second law of thermodynamics which justifies the concept of a linear time direction. The same term "entropy", in communication engineering of discrete signal sequences, de-couples the term from the temporal regime, transforming it rather into Markov and ergodic processes

- second law of thermodynamics argues for universal entropy and a gradual increase of disorder, "meaning the tendency for any system to dissipate with time, to lose its structure". There is a direct link to Shannon-entropy; statistical mechanics provided the measure of information, choice and uncertainty[72]

In Newton's abstract, mathematical, time-reversible physical mechanics, a cinematographically captured planetary revolution would remain intact even when projected backwards, different from the only statistically predictible molecular movement of gazes, liquids and clouds.

Software emulators in computer-based computer chip design measure time in clock cycles, estimate energy consumption in joules, and give realistic

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69 Thomas Richards, The Imperial Archive, chap. "Archive and Entropy", 82
70 Claude E. Shannon / Warren Weaver, The Mathematical Theory of Communication [*1949], Urbana / Chicago / London (Univ. of Illinois Press) 2nd. ed. 1972, 12 (reference to Eddington)
71 C. E. Shannon, Prediction and Entropy of Printed English [*1950], in: 50- (50)
72 Jussi Parikka, What is Media Archaeology?, Cambridge / Cambridge, Mass. (Polity Press) 2012, 100

estimates of code size in bytes. These affect the life of a battery, "and the size and expense of the computer's largest physical part: its memory."[73]

- Espen Aarseth identifies a "thermic" genre of computer-generated poetry beyond narrative: "ergodic" literature; Cayley's poetry generator *The Speaking Clock* is re-generative in terms of Bergons's critique of mathematized time[74]

- "Kanalspeicher", in: Horst Völz, Information, entry for Stefan Höltgen (ed.), Handbuch Technik für Medienwissenschaft, TS December 2016, 38, fig. 57

- transmission *medium* in Shannon's diagram is replaced by the storage medium for a therein (at an arbitrary moment in time) embodied / coded (transducer) time-variant signal $f(t)$ as carrier of information resp. noise $f(x, y, z)$. The signal here is frozen, until it is (at an arbitrary moment in later time) decoded as $f(t + T_{speicher})$. The channel capacity is measured in bits/sec. (telegraphy); its reverse in storage is enduring bits

- in statistical sense, "noise" comes in with the predictability of information transfer. "Thermal" communication theory extends to the technologies of cultural tradition itself. In communication-theoretical terms, there is insecurity resulting from the signal-to-noise ratio in the transmission channel (Shannon entropy): to which degree is the received, decoded signal the originally intended one (in archaeology: corrupt inscriptions; in philology: spurious texts). While in hermeneutics such insecurity is there in principle, guaranteeing open interpretation for eternity, the cryptoanalytic pragmatics (resulting in the successful deciphering of Mycenean Linear B writing by Ventris) knows that it is undecibable which distortion is intended (cryptography) or physical channel noise. For a cryptoanalyst, a secrecy system is almost identical with a noise communication system[75]

- Siegert 2003, 249: "Wenn die Luftschichten über der Wüste anfangen, zu flimmern und zu spiegeln, dann wird einem eine neue Mathematik geschenkt"; Fourier, when observing flickering heat waves over the Egyptian desert sand, realized with mathematical mind that by analysis, temperature physically embodies oscillatory processuality

- sentiment of high or low temperature corresponds with the varying pitch in sonic perception. Just like in Johann Sebastian Bach's exercises *Well-tempered piano*, we confront the alliance between temperature and *tempus*, since there is a temporal dimension within. Pitch is nothing but a cognitive metaphor for frequencies, the tone itself is identified as a periodic time event. Pitch may be understood as the microtime equivalent of rhythm[76] - and thus be calculated by

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73 See online Wikipedia, entry "Computer Architecture", accessed xxx
74 See Espen Aarseth, Aporia of Epiphany in Doom and The Speaking Clock. The Temporality of Ergodic Art, in: Marie-Laure Ryan (ed.), Cyberspace Textuality. Computer Technology and Literary Theory, Bloomington / Indianapolis 1999, 31-42
75 See Siegert, Relais, 1993, 290

76 See Karlheinz Stockhausen, ... wie die Zeit vergeht ..., in: Die Reihe. Information über serielle Musik, no 3, Universal Edition, Vienna / Zürich / London (1957), 13-42

discrete mathematics. Digitization means a radical transformation in the ontology of the sound record - from the physical signal to a matrix of its numerical values. Media culture turns from phonocentrism to mathematics

- negentropic persistence against thermodynamic time arrow owes its ahistoricity to its different form of registering: not by signals (such as a phonographic recording the physically real acoustic event), but by operative symbols (such as the musical score). With mathematical computing, sampling and quantizing of acoustic signals transforms the time signal into frequencies as analysis and as a condition for re-synthesis. Media culture turns from phonocentrism to mathematics

What started with temperature in Fourier's analysis of heat conduction finally resulted in digital temperament; automated analysis gives access to vibrational events by identification of its micro-temporal structures, beats and rhythm. The real time components of such a software analyzes waveforms by Discrete Fourier Transformation which in reverse can be (re-)translated and re-mediated into culturally familiar categories of sonic time structures - the "cool" jazz (McLuhan) of media theory.

- on thermodynamic level, monitoring temperature subtly interferes just like Maxwell's demon when observing molecules for informative choice: The physicist - or electronic sensor -, when making an observation, "transforms negative entropy into information"[77]

Frozen vibrations

- electro-magentic events (like light) occur at regular intervals millions of times, "but what if they repeat merely 10 times, five times, or only once? Identification of the definining limit cycle is elusive with so few cycles. <...> Occasionally, it is virtually impossible to draw a line between a true but transient oscillator and system with properties prone to oscillate: resonators" = Buzsáki 2006: 142

- slow down high-frequent oscillations from ultra-temporal to the sub-temporal level of perception - as an equivalent to cooling down temperature. An organ pipe with low frequency dissolves into discrete pulses at around 16 Hz (Norbert Wiener 1948). John Cage composed a music piece for organ (originally written for piano in 1985) called *Organ / ASLSP*, with the acronym ASLSP expressing "as slow as possible". In its installation at the Burchardikirche in Halberstadt, it is meant to last from 2000 (start) to 2639.

Storage of vibrations and their processual present are just two extreme formulations of one kind of event.

- human senses only perceive a fraction ("light") of the electromagneticspectrum; instruments extend human capabilities and detect radiation across the entire spectrum, from gamma to radio waves. EM

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77 L. Brillouin, Maxwell's Demon Cannot Operate. Information and Entropy, in: Journal of Applied Physics, vol. 22, no. 3 / 1951, 334-337 (337)

temperatures happen in the Ionosphere (indirectly audible in Short Wave Radio) and cosmic background radiation

Arctic conditions for signal and data storage: the museum case

- in post-industrial age, "information is information, not energy nor matter" (Wiener 1948). But high-frequency data processing, though apparently almost immaterial and hidden from obvious visibility, has resulted in more energy consumption than ever.

- negentropic computing memory, embodied energy costs and the memory of material objects correlate in the maintainance of cultural heritage in museums; energy cost of cultural memory maintenance, especially technological infrastructure of museums: Samir Bhowmik, Deep Time of the Museum: The Materiality of Media Infrastructures, doctoral dissertation, Aalto University, Helsinki (Aalto Art Books) 2016

Here, heating and cooling system are inverted by the process of digitizing the museum objects, that is: translating them into a different form of existence, from matter and energy to information with a different "temperature" ratio. There is data entropy in using the image scanner for the digitization of material heritage by scanning it into computers for further storage, processing and transmission, thereby turning the museum of artefacts into "cloud" collections for the representation and broadcasting of digital memory through networks, media installations and digitally-embedded museum spaces.[78]

- move from traditional to digital museum comes "[...] at the cost of an expanded media infrastructure that is energy-intensive and resource-dependent (draft Bhowmik 2016)", since "[b]ehind every act of digitization and digital representation lies a chain of material resources, silicon chip manufacturing (Cubitt 2016a) and dystopian toxic lakes (Maughan 2015). The life-span of this non-human infrastructure is limited and not only obsolescense drives a perpetual upgrading, but also, "used and obsolete media technologies return to the earth as residue of digital culture, contributing to growing layers of toxic waste" (Parikka 2015)" - the environmental burden carried by digital memory."

- Norbert Wiener's definition of "information" in *Cybernetics* 1948; in principle, a "bit" as unit of information is a quantity abstracted from both its energetic or material implementation. But as insisted by Szilard, any measurement must be recorded, be it written on paper or tape, or stored in a computer memory. "Information is physical."[79] Landauer proved that measurements (for information) can be realized at zero entropy production; the energetic costs rather results from the erasure of measurement memory. "The dissipation

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78 See Samir Bhowmik, "Deep Time of the Museum: The Materiality of Media Infrastructures." Doctoral dissertation, Aalto University, Helsinki (Aalto Art Books) 2016, esp. chap. 5.2.3
79 Rolf Landauer, as quoted in: Juan M. R. Parrondo / Jordan M. Horowitz / Takahiro Sagawa, Thermodynamics of information, in: Nature Physics vol. 11 (2015), 131-139 (131)

required to save the second law and to prevent us from making molecules in thermal quilibrium do work comes not from information transfer to the meter or control apparatus but from the subsequent resetting of that apparatus"; therefore Landauer proposes *reversible computation*.[80]]

For heating of private house which are supplied with sun energy-generated electricity, VARTA in 2012 offered a Lithium-Ione battery as buffer memory in exchangable modules, which allows for a modular use of current, combined with "intelligent" measuring of energy usage and distribution for the most profitable moments of currency price, plus intelligent switches / smart grids); "information" of currency itself, not only simply driving computers any more, but itself object of computing

- In 1887, William Thompson installs a cryospheric model glacier, the *Pitch Glacier*; here, the experimental time equals (one-to-one) with the modelled event itself - a true simulation.[81] Emphatic geological and macro-climactic "deep time" turns into "flat" temporealities once it is re-formulated in media-technological terms; research on climate change, for an extended time line the reconstruction of temperature in times past is essential, since immediate change (as being observed in the "presence window") is difficult to Fourier-analyse. Reliable recording of climate only began in the 1880. Just like with sound from pre-phonographic times, paleoclimatic evidence can not be measured directly; therefore indirect evidence by climate proxies stand in - physical remnants such as ice-cores and tree rings. With so-called "preudoproxies", such archeo-thermal research turns informational, applying algorithms to combine proxie records into a hermispheric temperature reconstruction. In this method which is highly vulnerable to computational uncertainty, "output from a climate model is sampled at locations corresponding to the known proxy network, and the temperature record produced is compared to the (known) overall temperature of the model"[82]

- computational mathematics (predictive analytics) now dramatically able to simulate climate change induced by its own (data center) energy cost itself, techno-epistemologically already one step ahead

- "A rapidly computing model [...] would be used in the verification of experimental work", Vladimir Zworykin announced in his "Outline of Weather Proposal" for the Princeton RCA Laboratories in October 1945 (p. 6), to keep pace with physical phenomena such as the weather. Reappearing on the computer screen, mathematical analysis (such as fractals) become dynamically *anschaulich*

80 Rolf Landauer, Information is physical, in: Physics Today (May 1991), 23-29 (26). See Harvey S. Leff / Andrew F. Rex (eds.), Maxwell's Demon. Entropy, Information, Computing, Bristol (Adam Hilger) 1990
81 See Christian Sichau, Die Replikationsmethode: Zur Rekonstruktion historischer Experimente, in: P. Heering / F. Rieß / ders. (Hg.), Im Labor der Physikgeschichte. Zur Untersuchung historischer Experimentalpraxis, Oldenburg (Bibliotheks- und Informationssystem der Universität Oldeburg) 2000, 9-70 (34, note 33)
82Entry "Proxy (climate)", from the online encyclopedia Wikipedia

Recirculating digital memory: the Delay Line

- like within the bi-polar oscillation between transmission and storage (conquering space or time) in cultural tradition, within the micro-cosmos of digital memory, records are either fixed in magnetic *latency* (such as ferrit core memory) or circulate in electro-algorithmic motion

- memory becomes a latency, coupled to the present in feedback loops which result in periodic up-dating

- envisioning a dynamic storage medium by wave speed, using thermic metaphors. In a closed circuit delay line, the signal as information carrier, at any time, is at a different point of space. By high-frequency modulation, though, it is possible to "freeze" such dynamic memory: "Zu einem passenden Zeitpunkt wird durch ein kurzzeitiges Hochfrequenzfeld die Welle im Kabel fixiert (gespeichert, eingefroren)." Horst Völz, Versuch einer systematischen und perspektivischen Analyse der Speicherung von Informationen, in: Die Technik 20 (1965) 10, 650-659 (659)

- dynamic data manipulation known from early dynamic computer "memories", such as the Acoustic (mercury-based, and other) Delay Line for re-circulating binary pulse trains, functioning as a variable, scalable temporal interval replacing the cultural idealism of eternal memory. But in a close reading, a tight coupling of temperature and memory arises: mercury delay lines are highly sensitive to temperature variation, thereby limiting or even distoting the clocked pulse trains in the intermediary memory channel. "The variation in the delay through mercury depends only on temperature."[83] What happens in storage here, is true for transmission of signals as well: In echo-location by the sonar (different from RADAR based on electro-magnetic waves), which is based on measuring the Delta-*t* passing between sending and receiving back the ultra-sonic (thus vibrational, mechanical) signal, time-criticality becomes temperature-critical, since the speed of an acoustic signal considerably varies with air temperature

- "delayed transfer" = term coined by Jack Goody for symbolically coded archival tradition; a coded message may be deciphered at any moment in later times (as long as the reader shares the knowledge of the originary alphabet)

Frozen voices: Making the temp*orality* of sonic world-signals symbolically calculable

- in early science fiction, trumpet signals (physical vibrations of a material medium) are literally being frozen in winter temperature like water waves at the shore. They defreeze in the spring sun as sound[84] - sonic time in latency.

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83 T. Kite Sharpless, Mercury delay lines as a memory unit, in: Proceedings of a Symposium on Large-Scale Calculating Maschinery, Cambridge, Mass. (Harvard University Press) 1948, 103-109 (105)
84 August Gottfried Bürger, Wunderbare Reisen zu Wasser und zu Lande, Feldzüge und lustige Abentheuer des Freyherrn von Münchhausen, London

The signal structure of defreezing is the sinusoidal wave indeed, the *tide*. This links is to literally the epistemological key term "Zeit" itself. "Unfreezing the captured vibrations"[85] in François Rabelais' *Gargantua et Pantagruel* (1532).[86]. A boatsman tells about a frozen lake where the noise and cries of a battle have cristallized in the icy air, waiting to be released in warmer springtime[87] - a fictitious, though plausible anticipation of phonographical sound recording and replay.[88] Charles Babbage, in his *Ninth Bridgewater Treatise* (1837), considered the air as an implicit sonic "vast library" of any vibration ever articulated, a superimposition of sine waves in eternity which can not only be mathematically analyzed (Fourier) but actually be retraced (Feaster). Grimmelshausen's *Baron Münchhausen's Adventures*, as well, chap. 5, tells the defreezing of trumpet signals (which are physical vibrations of a medium indeed) literally frozen in winter like water waves at the shore, defreezing warm spring as sound - sonic time in latency. Imagine the phonographic record of Martin Heidgger's speech *Die Kunst und der Raum* at St. Gallen starting to be slowly activated on a record player, defreezing infra-sonic vibrations, accelerating to uncanny articulations, until a deep recognizable voice slowly emerges from one and the same signal storage medium

- While Fourier analysis of heat waves ideally presupposes timeless signals, in reality, that is: implemented into physical / technical matter, oscillations are subject to increasing decay; they "die away <...> for which reason they are called transient"[89].

- elementary unit of a medium being-in-time is the time-varying signal. A phonographically recorded acoustic signal is not in its signal state but a graphic inscription. It becomes media-diagram only when operatively "de-frozen" by the time- based apparatus. The phonographic record waits for the mechanic player to defreeze its signals in a technological act of re-presencing

Cooling down media memory: video testimony

In archives of the moving image, it takes around twelve hours to dehydrate stored film material. Here, the archive is not a metaphor for icy memory, but becomes "cold" media memory itself; freezing slows down entropic degradation. In media archives around the globe the films rolls themselves are frozen down in order to withstand time. But the technique of the so-called *freeze frame* is important not just "to cinema's negotiation with time" <cfp>, but in a more general technological sense.

- "temperature" even in traumatic media memory. After the idea to audio-visually record the testimonies of Holocaust survivors was initiated in 1979 by

1786
85 Moore 2010: 291
86 Chap. 4, LVI
87 Siehe Moore 2010: 294f
88 August Gottfried Bürger, Wunderbare Reisen zu Wasser und zu Lande, Feldzüge und lustige Abentheuer des Freyherrn von Münchhausen, London 1786
89 Buzsáki 2006: 142

Dori Laub, it took shape as the "Holocaust Survivors Film Project. "Despite the name, filming was conducted from the start in videotape"[90] with the original recording format being three-quarter-inch U-Matic videocassettes. "Due to deterioration of the magnetic tape, the original videocassettes are currently stored in a temperature-controlled room in the Yale archives. The video testimonies currently available for viewing at Yale are all VHS copies of the originals."[91] This physical vulnerability of material carriers for audio-visual signals is being counter-acted neg-entropically by digitization; since the last years the material has been digitized, thus increasing the tension between storage and authenticity.

- in signal storage, so-called "archival tapes" (magnetophonic records) in broadcast archives (radio, television) need to be gently heated up to decoalesce in order to play them again for copying, digitizing and migration

- vulnerability of material signal carriers to physical entropy is being counter-acted ("neg-entropically", in Norbert Wiener's sense) by digitization. All of the sudden, passive storage turns into knowledge in latency. Once being digitized, the electronic image is open to algorithmic search options like similarity-based image retrieval. The traditional architecture of the archive is based on classificating records by external inventories / metadata. Analyzing a digital image from *within* allows for detecting order in fluctuation, that is: dynamic, which is an "archive" no more, but algorithmically ruled processuality.

- thermodynamics, transformed into data by informational calculus, returns within computation itself. After scanning an image, entropy defines "how easy it is to predict the unknown data values given the values we already know. If an image consists of a few monochrome areas, its entropy will be low"[92]

TIME MACHINERIES

term "equirimordiality"

- equiprimordiality = time being and time givenness of technical media; Michael Inwood, A Heidegger Dictionary, Oxford / Malden, Mass. 1999, 31: Heideggerian "gleichursprünglich" = "equiprimordial", "equally original"

- "*Cronopete is a Linux clone of Time Machine, the backup utility for Mac from Apple.* It aims to mimic it as closely as possible. The name comes from anacronopete ("who flies through time"), which is a time machine featured in the novel from Enrique Gaspar y Rimbaud, and published in 1887 (eight years

90 Amit Pinchevski, in: The Audiovisual Unconsciousness: Media and Trauma in the Video Archive for Holocaust Testimonies, in: Critical Inquiry, vol. 39, no. 1 (Autumn 2012), 142-166 (145)
91 Pinchevski 2012: 145, note 7
92 Lev Manovich, How to Compare One Million Images?, in: Understanding Digital Humanities, hg. v. David M. Berry. Basingstoke: Palgrave Macmillan 2012, 249-278 (266)

before than H. G. Wells'Time Machine)" =
http://www.rastersoft.com/programas/cronopete.html

Experiencing media tempor(e)alities

- abondoning the transcendet notion of "time": for case "historical time",
replace by (Boltzmann-) *entropy*; for case of temporal cuts: *time-criticality*

- technical *Eigenzeit* (the temporal logic inherent to its technologies) shapes
the collective perception of time in media-specific ways; time itself looses its
transcendent character and gets grounded in operativities. "Zeit ist damit auch
die Herausforderung einer Medienwissenschaft" = Stefan Rieger,
Kybernetische Anthropologie. Eine Geschichte der Virtualität, Frankfurt/M.
(Suhrkamp) 2003, 143. Apart from its "social media" content, the message of
the dominant communication platform of today, the World Wide Web, once
analysed on its operative level, is its temporal processualities and eventalities

- essence of technological media: their operative, processual, that is:
temporalized mode of existence; only when being in operation a medium is
truly in the medium state, otherwise the apparatus a piece of furniture; David
Morley, Television: Not so much a Visual Medium, more a Visible Object, in:
Charles Jenks (Hg.), Visual Culture, London / New York (Routledge) 170-189

- tele-communication extends to temporal de-distancing (Heidegger),
compressing the temporal gap between past / the present; from spatial to
temporal *proxemics*; "Time capsules make the timeline shrink. [...] Time
machines [...] have the capacity to make the timeline implode altogether by
teletransporting past things, no matter how far off temporally, to 'recency'",
thereby their "pastness" is destroyed: René Munnik, Technology and the End of
History. From Time Capsules to Time Machines, in: Liisa Janssen (ed.), The Art of
Ethics in the Information Society, Amsterdam (Amsterdam UP) 2016, 106-109
(109); see René Munnik, Tijdmachines. Over de technische onderwerping van
vergankelijkheid en duur, Zoetermeer (Klement) 2013; MED-PRESENCE

Chrono-technical irritations

- media time processes "within" concrete technologies (from analog to digital);
irritative (even traumatic) impact of media temporalites on the human sense of
time and finally results in most fundamental questioning of how media
technologies are situated within of apart from traditional historical time

- traditional model of cultural history is challenged by the chronopoetic
qualities of technological artefacts

- Jerrold Levinson / Philip Alperson, What Is a Temporal Art?, in: Midwest Studies
in Philosophy vol. 16 (1991), 439-450; reprint: Jerrold Levinson, Musical
Concerns: Essays in Philosophy of Music, Oxford 2015

- address media culture under the focused perspective of its technological
tempor(e)alities, on three levels: A close analysis of time-critical moments

within media technologies, followed by descriptions of how media temporalites affect and irritate the traditional human sense of time, and finally questioning the traditional position of media time within cultural history. The escalations of so-called time-based media analyzed in terms of time-critical processes, that is: procedures where the temporal moment is decisive for the overall success of the operation at all; requires most precise technical description on the one hand, and its media-epistemological explication on the other, in order to derive sparks of knowledge enriching the traditional philosophical discussions about the nature of time. The close microtechnical reading of time-critical processes then leads to discussing the phenomenological effects this has on human time perception. Media time actually questions familiar "cultural history". Far from remaining a transcendental signified, time itself thereby turns out to be radically pluralized by technological tempor(e)alities which generate a plethora of techno-mathematical terms enriching the vocabulary of temporal semantics - from delay time up to the autocorrelation function. The delicate microcosm of technical time figures deserves to be know beyond the internal language of engineers