[Wolfgang Ernst: NOTES ON TECHNICAL MEDIA]

NOTEBOOK "CHRONOTECHNIQUES"

[unedited cursory notes, theses, excerpts, grouped into thematic blocks; online www.medientheorien.hu-berlin.de, section "Ernst in English"]

Detailled content of thematic blocks:

NOTES ON TIME-CRITICALITY
Time-critical signal processing in humans and machines
Time-critical technical memories
Acoustic quanta in poetic prosody
Algorithmic "tempor(e)alities"
Just-in-time criticality
Telegraphic immediacy
Asynchonous Communication Media
Contemporary Condition(ing) in media culture
Not to be confused: Media operativity and cultural bias
Media Becoming Time-Critical
Technical "time" shift

NOTES ON TIME SIGNALS
- Questioning "Time"
Electricity: The media-archaeological index of McLuhan's media theory
Narrative time vs. storage and non-linear time
Non-narrative computational time
The temporal defect of Fourier Analysis
Temperature in technological terms: data-entropy, energy, information

NOTES ON CLOCKING AND TIME-KEEPING
- Vibrating sense of time: between liturgy and machine
- Ruptures between cultural techniques and media technology
- Chronology, Clock, Rhythm vs. Monastic Planning of Time
- The Epistemogenic Artifact: the Wheeled Clock Escapement
- On the Ritual and Liturgy of the Wheeled Clock: Media Archaeology versus - Media Anthropology
- The Anachronism of the Ticking, Wheeled Clock

NOTES ON THE AUDIO-VISUAL, AND ITS (A)SYNCHRONICITIES
Electro-Acoustic Space, and the Sense of Time
Asymmetries between the auditive and the visual
A critique of the term and the notion of the "audiovisual"
"Live" is not *live*
Kinaesthetics of the electronic image (with Viola)
Audiovision with Bill Viola
Media of audio-vision: Sound film and music video

From silent movies to film sound
... with Chion
The neurological basis for synesthesia and its electrophysiological detection
Is there a specific sense of time?

NOTES ON MEDIA THEATER
"Richard Two Bodies"
Hatsune Miku "on stage"
Non-"museal", operative material media archaeology (MAF, Signal Lab)

NOTES ON TECHNOLOGIES OF TRADITION
Cultural tradition / transmission in terms of communication theory
"Cultural value" and the sense of time
Resisting acceleration: the material delay function of 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"

==========

NOTES ON TIME-CRITICALITY

Time-critical signal processing in humans and machines

- the time-critical *is* the temporal (in its etymological sense of "cutting, dividing")

- cinema "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; inner time-economy of film (time-discrete, vs. video signal); time of mechanical film recording / projection slightly varying depending on individual apparatus (e. g. Bolex hand camera without / with frame counter)

- *time-based media* in Edmund Husserl's sense: "By temporal objects in the specific sense we understand objects that are not only united in time but that also contain temporal extension in themselves" = Edmund Husserl, The Phenomenology of the Consciousness of Internal Time [1893-1917], trans. John Barnett Brough, Dordrecht / Boston / London (Kluver) 1991, 24; "time-based media" not just existing in time but perform temporal procedures in themselves and thus might more appropriately be called *time-basing media*; Museum of Science and Technology in Manchester, where veterans display the "Williams-Kilburn Storage Tube" in the first stored-program electronic computer (the Manchester "Baby" / Mark I) *on the run*: a mad dance of dots and dashes,

pure visible bits, a (in)direct insight (by parallel coupled oscilloscope) into a *computer at work*

- time-criticality differing from simply time-based processes; video art (Viola) as articulation of "Bergsonean" temporality and materiality; around 1900, with Henri Bergson, solid matter began to be perceived as a vibrating element; image as stable configuration dissolves into signal temporality of electronig image; temporal gap between technological and human perception opens; 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

- 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; signal processing as a topic of technically applied mathematics - in the neo-cybernetic sense - does not refer to electrical engineering only: 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; time-varying quantities; sonography, electrocardiograms

Time-critical technical memories

- disappears the clear distinction between what is present and what is past, what is transmitted "live" and what comes out of the archive

- 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;

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

Algorithmic "tempor(e)alities"

- temporal(ized) logics: classic syllogism "All humans are mortal. Socrates is a human. Therefore Socrates is mortal" referring to his bodily entropy, while his words (*lógoi*), recorded alphabetically, could almost losslessly be transmitted across millenia; syllogistic argument itself negentropically claims immortal plausibility

- logical reasoning (like the syllogism, and the calculus) more or less invariant towards cultural, historical and discursive change, so-called "temporal logic" of intensional nature and therefore vulnerable to temporal mistakes; formulas evaluated not in abstract space from outside time (as in classical logic), but temporally local, i. e. at points of time; in temporal logic, propositional elements either true or false depending on their point of time; first order temporal logic with "until" and "since"; even games in temporal logicc = D. Gabbay et al., Temporal Logic. Mathematical Foundations and Computational Aspects, vol. 1, O. U. P. 1994; H. Kamp, Formal properties of "now", in: Theoria vol. 37 (1971), 237-273

- 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

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

Just-in-time criticality

- 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" 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 critical in terms of delays; while crisis of stock market in 1980s partly due to traders delaying answering their phone calls, nowadays nonhuman "calls"

- living part-time in the "off-line" mode, temporal gap opens between time stamp of message written into mail program 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 as 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.

- real-time web a set of technologies such as *instant messaging* "which enable users to receive information as soon as it is published [...], rather than requiring that they or their software check a source periodically for updates" = http://en.wikipedia.org/wiki/Real-time_web

- "dating" communication (known from postal letters in previous time on a calendar day basis, now escalates into "dating" the message down to the minute), f. e.: "On Monday, 23.05.2011, 00:26 +0200 wrote N. N. ..."; bizarre off-spring of this discourse term and practice of "speed dating", cutting short the temporal intervall which is integrated into what is addressed by the technical term "realtime"

Asynchonous Communication Media

- on occasion of an academic video seminar between Tokyo and Berlin: Japan time 7 hours ahead; already part of "inner time sense" (Husserl 1928) and an extended window of the present, unfolding between re- and protention: will phenomenologically feel as if Berlin was already communicating from the past into the Tokyo future, even if synchronized in virtual "Zoom" space

- "recursion" being itself a dominant time-figure of contemporaneity in the sense of Erkki Huhtamo's media-archaeological *topoi*)

Contemporary Condition(ing) in media culture

- any technological device a multi-temporal hybrid; different from the "diachronic" geological or archaeological layers (so-called "deep time"), existing for 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. One 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" = Michel Serres, Conversations on Science, Culture, and Time, Michigan (Univ. of Michigan Press) 1995, quoted (as motto) in: Timothy Barker, Re-Composing the Digital Present, in: xxx, 88-103 (89); a techno-archival defining condition of the "historical present" - historicism, or present-in-the-past?

- 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

- 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 oscillating 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*"

- a psychophysical experiment where a quantum light source generates discrete states of light; human can detect a single-photon incident significantly above chance, since "the probability of reporting a single photon is modulated by the presence of an earlier photon, suggesting a priming process that temporarily enhances the effective gain of the visual system on the timescale of seconds" = "Direct detection of a single photon by humans", in: Nature Communications 7, article number: 12172, doi:10.1038/ncomms12172 (retrieved 25 July, 2016), abstract

- 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

Not to be confused: Media operativity and cultural bias

- abstract, quantitative time of watches and clocks culminating in chronophotography (the precursor of cinema) and Gilbreth's media-technical measurements of smallest temporal units in working processes to optimize production

- 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 the verge or anchor escapement; pendulum ensuring that a steady rate is maintained. 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

- symbolic ordering of time in liturgic rituals categorized under "cultural technologies", in decisive difference to genuine media opperations;epistemological discontinuity: separate religious timing from technical processes based on equi-temporal (periodic) oscillations (Huygens)

- technologies, once in operation, 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?

- 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 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

Media Becoming Time-Critical

- electronic media (such as video art, as defined by Bill Viola) not simply time-based (as defined by Gotthold Ephraim Lessing in 1766 in his treatise *Laokoon* where me makes a semio-aesthetic difference between space-based and time-based media, that is: between visual arts and poetry), but confronted with a new type of artifical temporality: time-critical processes

- notion of "instanciation" in programming computers; internal "interrupt" procedures revealing the delicate micro-temporal and decision-critical economy (synchronisation, clocking) of data processing within computers, a permanent interplay between internal data processing and input from the outside world, as performed daily in computer games (action games), described by Claus Pias in his *Computer - Spiel - Welten*

Technical "time" shift

- last minute editorial question / suggestion concerning title of article W. E., "DOES TIME 'MAKE SENSE' TO MEDIA?", forthcoming in: Natasha Lushetich / Iain Campbell (eds.), Distributed Perception: Resonances and Axiologies (Routledge), expected for 2021: "add an endnote to explain the use of the word ‘sense’ or would you like to place it in inverted commas? […] Linguistically, ‘sense’ is related to ‘sentience’ ["Empfindungsvermögen"] which means that - from the purely linguistic point of view – non-sentient things don’t have sensations. Making sense is an embodied-neural-cognitive operation so it’s different from ‘sense’, experience, etc, of course; we have a range of chapters questioning other-than-human sensing, as you could expect in a volume with this title so a reference to some of the the uses of sensing is certainly possible." = Natasha Lushetich, May 13, 2021; Daniel Stoecker (Research Group »SENSING: The Knowledge of Sensitive Media«, ZeM – Brandenburg Centre for Media Studies, www.sensing-media.de), electronic communication May 25, 2021, "zur Frage nach Trennbarkeit (und Sinnhaftigkeit einer Trennung) der beiden Bedeutungsebenen aus sensing als der sinnlichen Erfahrung oder Sensibilität einerseits und dem sense-making als Stiften von Sinnzusammenhängen andererseits"; a “Germanism”? thinking of expressions like “stop making sense" - accepting proposal to apply inverted comma, which will then (re-)move it from “time”, in return - a decisive change of meaning / “sense”; editors obviously tending to suppose "time" as a given transcendent reference, against which technical media deviate, against rather radical questioning of "time" itself from the media-archaeological point of techno-view; final title therefore a literal "*time*" *shift* / deferral / *différance*: "DOES TIME 'MAKE SENSE' TO TECHNICAL MEDIA?"

NOTES ON TIME SIGNALS

- in analytic geometry, "time", as the 4th dimension, still thought as extension of Cartesean space

Questioning "Time"

- "time" scientifically / in signal engineering defined parametrical, as f(*t*); alternatively in reverse: "time" as a function / integration of change; de-transcendize cultural concept of "time" as an effort to symbolically cope with change / movement in semantically meaningful way

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

- electronic speed of wireless or cable-based commmunication such as telephony not involving material / mechanical transportation vehicles any more, with its "electrons" being almost completely liberated from matter and energy and rather taking place as world of contiguous pulses; in the world of electronics, speed not conceived as conquering of space (movement) any more but as ultra-short temporal moments

- McLuhan's analysis of electrically configured media / Paul Virilio's dromology; speed at which information travels, undoing spatial distance by almost synchronous communication, "the electric environment of instant circuitry" = McLuhan 1964: x, where “the action and the reaction occur almost at the same time"; speed-up of information flow with electricity-based media which McLuhan opposes to 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 so-called *real time* (and the so-called Real Time Internet)

- McLuhan interpreting electronically mediated communication as a contraction of the global world into pure tele-presence; this contractions 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, thereby creating a techno-communicative society from within

- in times of Internet protocols, what McLuhan has described metaphorially becoming literal; time-critical processes taking 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 = Christoph Neubert, Elektronische Adressenordnung, in: Stefan Andriopoulos et al. (eds.), Die Adresse des Mediums, Köln (DuMont) 2001, 34-63 (41); such identification of signals happening within the time-critical field, such as signal frequency and signal duration, synchronous or asynchronous clocking, and the decision on serial or parallel data transfer

Narrative time vs. storage and non-linear time

- "historical memory" privileging narrative form of representation; past / storage may as well be computed (between *conter* and *raconter*, in French) - actually closer to the archive, *histoire serielle* as proclaimed by École des Annales =François Furet, Quantitative History, in: xxx; operating with variables in a process of truly mathematical analysis, algorithmical procedures

- storage time "empty" form, not dynamically unfolding, but invariant *stasis* = Götz Großklaus, Medien-Zeit, Medien-Raum: zum Wandel der raumzeitlichen Wahrnhemung in der Moderne, Frankfurt / M. (Suhrkamp) 1995, 47

- with short time-exposed photography, the unique temporal moment / (exposure-extended) "now" becoming reproducable (Roland Barthes) - extended to life-as-movement by kinematography

- with technomathematical electronic media, non-linear time becoming the dominant temporal figure; in 20th century, dominant pieces of composition do not causally unfold any more, neither do they end in a harmonic, conflict-resolving *finale* = Hans-Ulrich Fuss, Musik als Zeitverlauf. Prozeßorientierte Analyseverfahren in der amerikanischen Musiktheorie, in: Zeitschrift der Gesellschaft für Musiktheorie 2/3 (2005), http://www.gmth.de/zeitschrift/artikel/205.aspx, accessed July 2009; equivalent to media-technological *Eigenzeit*

Non-narrative computational time

- with hypertextual media (computer games, and the World Wide Web), non-temporal modes of beginning and end: hypertime; point and moment to step almost arbitrary

- 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*

- very act of observation (Spencer-Brown's "draw a distiction") requiring a temporal act; the switching of digital binary (which Wiener coined "time of non-reality"; in theory, this micro-temporal inbetween literally does not count)

- reformulating cognitive processes in technologically induced terms (the binary electro-mechanical relay), thinking takes switching time (Wiener's "time of non-reality")

- the tempoReal between binary switching states. The moment of switching itself, termed by Norbert Wiener as "time of non-reality", lies outside the theoretical scope of automata theory; Zuse 1967: 343

- "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; 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; media theorist Lev Manovich (in a chapter of his book *The Language of New Media*) calling this the aesthetics of data banks, corresponding with a data-archaeological information ascetics. Beginning and end, in computing media, are not structured by dramatical structures any more, but by the (equally complex) logic of *count down*.

- "That which decays is not software" = initial statement in Marisa Leavitt Cohn, Unruly Bodies of Code in Time, in: Volmar / Stine (eds.), Hardwired Temporalities, chap. 10 (forthcoming)

The temporal defect of Fourier Analysis

- superposition of the periodic waves generating a complex signal implying the temporal *aporia* of its Fourier analysis; Dennis Gabor criticizing the idealism of harmonic Fourier analysis in 1948; hypothetically endless and beginningless periodic waves missing 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

- Fourier Analysis ideally supposing infinitely extended sine waves as its components with no definite origin or ending, 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; frequency information which is the result of a Fourier transform mathematically precise but on the expense of tempor(e)al precision. 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; 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" quantizing the time domain itself = Denis Gabor, Acoustical Quanta and the Theory of Hearing, in: Nature Nr. 4044, 159 (May 1947), 591-594

- 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

Temperature in technological terms: data-entropy, energy, information

- "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" = Pattee 1974: 130

- 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

- Markov chain analysis "flat historicity"; probability of a chain of strings from a finite alphabet to turn up in a discrete sequence 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

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

- 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

- any transformation of entropic states into improbable information negentropic. Maxwell's demon may be equipped with a torch = Brillouin 1951; 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 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" = Thomas Richards, The Imperial Archive, chap. "Archive and Entropy", 82

- in physical science, entropy names the tendency of element distribution in closed systems to become less and less organized, providing time with its "arrow" in accordance with the Second Law of Themodynamics = 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); on the contrary, informational state 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*

- "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" = C. E. Shannon, Prediction and Entropy of Printed English [*1950], in: xxx, 50- (50)

- 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

- Shannon-entropy; statistical mechanics provided vocabulary for measuring information, choice and uncertainty

- in Newton's abstract, mathematical, time-reversible physical mechanics, a cinematographically captured planetary revolution remaining 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 measuring time in clock cycles, estimating energy consumption in joules, and give realistic 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" = Wikipedia, entry "Computer Architecture"

- Espen Aarseth identifying 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 = 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

- "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 = Siegert, Relais, 1993, 290

- acoustic pitch nothing but a cognitive metaphor for frequencies, the tone itself a periodic time event; pitch the microtime equivalent of rhythm = Karlheinz Stockhausen, ... wie die Zeit vergeht ..., in: Die Reihe. Information über serielle Musik, no 3, Universal Edition, Vienna / Zürich / London (1957), 13-42; thus calculable by 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 owing 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 transforming the time signal into frequencies as analysis and as a condition for re-synthesis; media culture turning from phonocentrism to mathematics

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

- 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" = 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); measurements (for information) can be realized at zero entropy production; the energetic costs rather results from the erasure of measurement memory. "The dissipation 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* 0 Rolf Landauer, Information is physical, in: Physics Today (May 1991), 23-29 (26)

- for heating of private house supplied with sun energy-generated electricity, VARTA in 2012 offering 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

- emphatic geological and macro-climactic "deep time" turning into "flat" temporealities once 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; this method 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" = entry "Proxy (climate)", Wikipedia

- 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*

NOTES ON CLOCKING AND TIME-KEEPING

Vibrating sense of time: between liturgy and machine

- "There is clocklessness, for sure, but no such thing as 'timelessness'" = Elena Esposito, Die Konstruktion von Unberechenbarkeit, in: Avanessian / Malik (eds.) 2016, 37-42; *vice versa*

- "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 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 corresponding 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 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 enduring: not *in*, but *as* inherent archive (Foucauldean *l'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 modification of monastic *clocking* mechanism by explicitely adding escapement. Even if this must have happened at once peculiar instance by an individual creative act, 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 apt fpr accepting the fragmentation of life into minutes and hours = Marshall McLuhan, *Understanding Media. The Extensions of Man* (New York: McGraw Hill, 1964), 142; time 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 becoming dynamic with the wheeled clock; with advancing precision, temporal intervals infinitesimally converging on zero; temporal perception thereby mechanically specified, and later cast by Newton and Leibniz into mathematics

- computer 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 transforming Medieval "annalistic" macro-time into a microphysics of time

- Aristotle, in a techno-constructivist rather than phenomenological way (St. Augustin) defined time as motion to which numerical values can be assigned by measuring; concept of an estimated vanishing point in alliance with zero in mathematical calculation, producing 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)

- with its mechanical escapement, wheeled clock producing precise temporal beat in the form of a pulse sequence, with equal intervals; based on such oscillations, machines later generating 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.

- with development of the pendulum clock, mathematical counting of movement becoming autonomous, as a metronom to measure time; in 1377, Nicolas d'Oresme comparing 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 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.

- symbolic clock "time" or coordinated world "time" momentous orders that are themselves only temporarily capable of forming regular regimes = Isabell Otto, Infrastructuring Leap Seconds: The Regime of Temporal Plurality in Digitally Networked Media, in: Volmar / Stine (eds.), chap. 5

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 resulting 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 / M. (Suhrkamp) 1963, 17; also Jonathan D. Kramer, The Time of Music, New York / London (Schirmer) 1988, 68; such emancipation 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 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 "escaping" 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; Dante Alighieri describing in the *Divine Comedy* a wheeled clock with a mechanical escapement around 1320; notwithstanding such references, invention of the verge-and-foliot escapement-driven clock belonging to what Sigfried Giedion describes as anonymous history = Siegfried Giedion, Mechanization Takes Command, Oxford (Oxford University Press) 1948; astronomical clock furnished with a kind of escapement mechanism already introduced into China in the year 1092, Gerhard Dohrn-van Rossum still considering

the foliot escapement as "in all likelihood an independent European development" = Dohrn-van Rossum 1996: 105; strictly media-archaeological argument; Chinese clock containing 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. "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 ordering required, reacting asymmetrically to the temporal economy of telling the "origin" of the escapement as a moment precisely registered in historiography; media archaeology rather referring to the discrete time of machines as to the symbolic time of human culture called "history"; digital beat of clockworks and the discrete series of letters in archival records 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.

- instead of three times past, present, and future, "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; thereby implicit 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.

NOTES ON THE AUDIO-VISUAL, AND ITS (A)SYNCHRONICITIES

Electro-Acoustic Space, and the Sense of Time

- 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; Christian Kaernbach, entry "Echogedächtnis", in: Nicolas Pethes / Jens Ruchatz (eds.), Gedächtnis und Erinnerung. Ein interdisziplinäres Lexikon, Reinbek (rowohlts enzyklopädie) 2001, 132 f., referring to N. Cowan, On short and long auditory stores, in: Psychological Bulletin Nr. 96 (1984), 341-370

- "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 language, code this meaning symbolically, 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. [...] Today, there is a nearly constant flow of information at all times" = Schwartz 1974: 23 f.

- "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"; Platon's *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 media-archaeological 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

- "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; Assembly language

- separation of "figure" and "ground" = McLuhan / Powers 1995, Das resonierende Intervall, 25-36 (25); with the electric image the ground returning - 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 on the technological options of electronic coding

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

- time and number "fundamental non-verbal aspects of cognition" = Dale Purves (ed.), Principles of Cognitive Neuroscience, Sunderland, MA (Sinauer), 4th ed. 2008, 51; located in the brain area that cares about sequential ordering (the number form); around 1980, Meck and Church proposing that time and number represented by the same representational currency

Asymmetries between the auditive and the visual

- film transmitting visual information by "projecting a series of still pictures in rapid succession" = Michel Chion 1994, 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" just like textual reading. "This differs considerably from visual experience in everyday life, where the eye is bombarded with a continuous stream of information" = ibid.

- 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

- ear specialized 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); cinematographic effect; 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 inscribing 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 László Moholy-Nagy declared *Optofonetik* as the media art of the "Optisch-Kinetischen" and the "Akustisch-Musikalischen", *vice versa* the cathode ray tube has been used for visualizing 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, calculating 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 = Uwe Sander, Die "fehlende Halbsekunde", in: Handbuch Medienpädagogik, xxx (Springer) 2008, 290-293 (292); a

lightning strike 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 the present at all = 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)

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; slow speed of sound (as compared to the proverbial speed of light) irritates the visually orientated perception; 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 metaxy*), pre-theoretical term for "media" (as channel, defined by Shannons "Mathematical Theory of Communication")

"Live" is not *live*

- in 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

- no audio-visual (a)symmetrie, rather derivative: video image recording born out of sound recording = Christian Doelker, Kulturtechnik Fernsehen. Analyse eines Mediums, Stuttgart (Klett-Cotta) 1991, chapter "Ton versus Bild", 185

- while electromagnetic sound recording realised in linear "writing" like the mechanical phonograph, image recording (video) requiring a decisive

modification of the medium, the rotating magnetic tape writing head in oblique, counter-directive way to cheat the temporal axis

Audiovision with Bill Viola

- time-critical message of sound within space; once the impression of space 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 becoming 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 (*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" = 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" = 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" = 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" = 42

- multitude of *chronoi* (Aristoxenos) indeed, as a function of techological *Ge-stell*; "there might be 'many times' which are subjected to 'various contexts' indeed" = Tomoko Tamari, electronic communication April 21, 2021, on "time differences"

- propagation of acoustic waves requiring 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 = Gottfried Ehrenstrasser, Stochastische Signale und ihre Anwendung, Heidelberg (Hüthig) 1974, 90 f.

- "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, 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); 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 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 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" = 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"

Kinaesthetics of the electronic image (with Viola)

- video image, with its divisions into lines and frames, "a living dynamic energy field, a vibration appearing solid only because it exceeds our ability to discern such fine slices of time" = Bill Viola, The Sound of One

Line Scanning, in: Dan Lander / Micah Lexier (Hg.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54 (44)

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

- 1911 Henri Bergson's *Creative Evolution* associating the thought process with the time-discrete form of the movie; his *Matter and Memory*: merging of past with present perceptions in the diagram of a geometrical cone inspired by phonographic recording and its re-enactment by the mechanic (later electro-magnetic) pick-up?

- 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)

- "Musically 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 addressing the content, *explosive time* = Michael Rubin, Nonlinear. A guide to digital film and video editing, 3rd ed. Gainesville 1995

- 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, creating the impression of synchronicity

From silent movies to film sound

- hyphen both binding and separating 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" term) 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.

- 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 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 = Friedrich Kittler, Optische Medien. Berliner Vorlesung 1999, Berlin (Merve) 2002, 276 images contain two further spatial variables

- storage of sound linear (phonographic groove), like a graphic inscription of the time line, whereas cinematographic movement requiring discrete storage in single frames: punctual, "logical" time

- technical synchronisation of two sensorial channels; 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 light 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 breaking apart both technologically and in human perception

- cultural prefiguration intervenes: In narrative video-clips the perception integrates audio-visual differences in other ways than for non-narrative video-clips = Schlemmer 2005: 183; 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 Chion, L'Audio-vision (1994), 16

... with Chion

- time-critical difference between the physiological processing of images and sound; different average pace in sound vs. visual perception; "basically, the ear analyzes, processes, and synthesizes faster than the eye"

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

- 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

- time-critical acoustics; "a paradox: we don't hear sounds, in the sense of recognizing them, until shortly after we have perceived them. [...] 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" = Chion 1994: 13

- "visual microrhythms [...] 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

The neurological basis for synesthesia and its electrophysiological detection

- 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 = 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: 173-184 174

- media-archeological argument: electrophysiological high-sensitive (vacuum-tube-amplified) measure instruments necessary 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 vacuum tube amplifier it has been possible to detect smallest electric currents passing through nerves.

- neuroscientist Robert Galambos in the 1930s implanting 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" = paraphrase of a comment by Steven A. Hillyard 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); http://www.nytimes.com/2010/07/16/science/16galambos.html, accessed July 21, 2010; 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 becoming tight, since Shannon switched communication engineering from analogue to digital transmission, with impulses representing the informational unit of a bit and allowing for the "ciphering of the real" / "Verzifferung des Reellen" = Friedrich Kittler, Optische Medien. Berliner Vorlesung 1999, Berlin (Merve) 2002, 320; coincides with the detection of pulse trains in human signal perception

- Galambos' 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?

- neuroscientific vocablulary to describe the cognitive timing processes within the human brain resembling the description of technological tempor(e)alities

- human sense of time operating over different scales; involving a variety of neural systems; "not clear whether there is a central internal clock for interval timing" = Dale Purves, Principles of Cognitive Neuroscience, Sunderland, MA (Sinauer) 2008, 51; for interval timing 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

NOTES ON MEDIA THEATER

"Richard Two Bodies"

- "On the one hand, the weakened body becomes a prosthetic to the media-net; and on the other the body electronic is data trash struggling to come alive again in recombinant form" = Arthur Kroker / Michael Weinstein, Data trash, New York 1994, 3

- 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"

- "vocaloid" as 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"

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 possible 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 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 (material decay) as evidence of one-directional physical time; second law of thermodynamics announces 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; stochastically defined "information" (mean predictability of bit sequences) can be preserved almost without loss; material entropy (except from "quantising 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

- non-functional machines and electronic elements in the MAF a 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); concerning source code in the case of ancient computers, name of the machine-orientated programing language ASSEMBLY taken literally: dis- and re-assemble it; media-ontological definition that a technical apparatus is in existence only when being operative, requires 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

- 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" for 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)

- analogue media archaeological artifacts requiring 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*

NOTES ON TECHNOLOGIES OF TRADITION

Cultural tradition / transmission in terms of communication theory

- "technologies of cultural heritage": archives, libraries, museums and the machines they use to store, retrieve and update sources

- when coupled to electronics, record from the past no more primarily marked by ageing of matter nor loss of energy, but becoming apparently timeless signals; in terms of core media operations of cultural tradition like signal recording and re-processing, the imaginary of "deep time" shrinking to near-immediacy

- eye not the fastest channel of acquiring knowledge but logical reasoning, as expressed by Goethe in *Dichtung und Wahrheit*, but the word: "Das Auge mag wohl der klarste Sinn genannt werden, durch den die leichteste Überlieferung möglich ist. Aber der innere Sinn ist noch klarer, und zu ihm gelangt die höchste und schnellste Überlieferung durchs Wort, denn dieses ist eigentlich fruchtbringend" = quoted after: Wolfgang Iskra, Die Darstellung des Sichtbaren in der dichterischen Prosa um 1900, Münster (Aschendorff) 1967, 41; words escalated into data

strings in algorithmically coded machines, in the programming of the computational executions which are the hidden agencies behind all apparent interface iconicity and metaphors

- 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" = Shannon / Weaver, The Mathematical Theory of Communication (1949), 31

"Cultural value" and the sense of time

- instead of traditional endurance, changing values the signature of modernity; drama of modernity the 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" = as recalled by P. Janet, L'Evolution de la Mémoire et de la Notion du Temps, Paris (Chahine) 1928, 28; still an analog notion of continuous time; 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" (Rossaak). 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" = 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 (29 f.)

- GPS; "real time of ubiquity and instantaneity, [...] less physical than microphysical" = Paul Virilio, L´écran du désert, zitiert nach: Laura Kurgan, You Are Here: Information Drift, in: assemblage 25 (1995, MIT), 15-43 (28)

- in a networked world, money moving 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

- where relative value of currencies changes from moment to moment, exact time stamp 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

- "frequency domain" of what is the "time domain" in telecommunicative signal transmission; its capitalist value: it can be measured; 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

- "candidate for replacing the desktop is called 'Lifestreams'" = David Gelernter, Machine Beauty. Elegance and the Heart of Technology, New York (Basic Books) 1997, 102. "Every time you use a creative work in a digital context, the technology is making a copy" = Lawrence Lessig, Remix. Making Art and Commerce Thrive in the Hybrid Economy, London (Bloomsbury Academic) 2008, 98; no more entropic time inbetween original and copy; singularity and endurance of the traditional work of art replaced by ephemerality and logical (rather than Benjamin's analog) reproduction as co-originary recreation; material embodiment (which is still required) itself becomes transitory, a function of algorithmical computing.

Resisting acceleration: the material delay function of museums

- position of the museum as a beholder of cultural materiality against the background of digital acceleration; museum positioning itself within the time-critical window of the operative present; storage value subject to

endurance, which is increasingly shrinking. 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.

- 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 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.

The new role of the museum (object)

- indicative of the digital condition: traditional material object 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

- shift of emphasis from fixation to transmission of cultural value

- museum becoming 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: *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" = Winfried Nöth, Handbook of Semiotics, Stuttgart 1990, 178

- 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* (1939 / 40) he wrote that the past can only be recorded as an image which simply flashes through one's mind at the moment of its dicernibility never to be seen again = Walter Benjamin, Selected Writings, vol. 4: 1938–1940, edited by H. Eiland / M. W. Jennings, Harvard University Press 2003; architectural memory of museums liquefying. Mnemosyne might have been the mother of the muses; the museum though is not concerned with 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; disintegration of the Kantean *a priori* of space and time by the technological *a priori*, in favour of speed (Virilio) and non-linear connection (Internet communicatin); advancing immaterialising of information; signal events caught up by recording systems in real-time; „other places“ like the museum (Michel Foucault) become nostralgic retro-effects

Up-Dating "Museums on the Digital Frontier" (Kittler)

- museum in digital culture not simply 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" = 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 (77); von-Neumann architecture of computing replacing 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.

- Github as the contemporary museum of algorithms, "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" = 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)

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

- inbetween the classical museum and the virtual museum as a function of computer simulation and CAD: the computer itself as a media-archaeological artifact

- computers from the early time of electronic and analog computing as big as rooms, thereby literally accessible such as the UNIVAC in the German Museum (Deutsches Museum) in Munich

- less metaphorical navigation of "computer space" by reading its operative diagramm (electronic circuitry itself)

- concept *Museum of Algorithms* (zu Salm); Kittler's "Museums on the Digital Frontier"; an understanding of "virtual architecture" resp. "algorithmic design" from its condition of possibility; media-archaeological "layers" of computing architecture; archival / algorithmic "tectonics"; think the digital archive from the computer architecture (both hard- and software)

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 = https://www.rijksmuseum.nl/en/rijksstudio; 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

- complex game of finding and relating objects to each other with the possible use of 200 000 objects

- 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)