

NOTEBOOK "CHRONOTECHNIQUES"

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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")

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

- *time-based media* in Edmund Husserl's sense (*Zeitobjekte*): "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 (Kluwer) 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 direct insight into a *computer at work*

- time-criticality differing from simply time-based processes; video art (Viola) as articulation of "Bergsonian" 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 electronic 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 ethnomusicology; 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, Δt ; Lionel Pearson, Introduction II: The Greek Theory of Rhythm, in: Aristoxenos, *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; *frequency 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 Džulić 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 eventuality 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 logic = 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-presenting 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 Artificial 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 ('representing') through technical media

- *aura* (as defined by Benjamin) depending on being "here and now"; technological *tempaurality* 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 Newton's 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 *telegraphy* "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 interval which is integrated into what is addressed by the technical term "realtime"

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?

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

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

- 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 communication

- 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 crashes" in HFT: irruption of temporal exception / faster than time / the traumatic "temporeal"

- 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 of temporalities

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

- decisive mechanism defining the "truly mechanical clock" = North 1975: 392 from traditional astronomical mechanisms is verge or foliot escapement (such as Giovanni de' Dondi clock); later replaced by the pendulum. Periods of swing (oscillations) once restricted to observation of planetary systems for agricultural use, when mastered by mechanic knowledge, becomes fundamental parameter for micro-temporal events, opening media-operative measuring devices insight into a world of time-critical operations unknown to human perception (*aisthesis* / aesthetics) before. Media archeology not interested in ways in which oscillatory mechanism for both measuring time and striking a bell in the thirteenth century "was absorbed 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-discursively 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 oscillatory mechanisms follows a logic of its own

- symbolic ordering of time in liturgic rituals categorized under "cultural technologies", in decisive difference to genuine media operations; 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

NOTES ON TIME SIGNALS

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

- electronic speed of wireless or cable-based communication 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 what we now call *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, McLuhan's thesis requires closer reading; what he has described metaphorically then has become literally true. Time-critical processes take place in its most media-archaeological sense, that is: on the basic layer of bit transfer in the, the *physical layer*. This layer represents the

interface of symbolic transfer to the material (or electro-magnetic) channel of communication (such as copper cables, wireless directions, light waves lines) and thus embodies very concretely the interlacing of logi(sti)cs and matter which is already implied in the term "technology". It is on this layer that the voltage level of what is meant to represent a logic "zero" and a logic "one" is being defined. The function of this bit transfer layer is in the transformation of signals within a physical transfer channel into information in order to be passed further to level two of the OSI system = Christoph Neubert, Elektronische Adressenordnung, in: Stefan Andriopoulos et al. (eds.), Die Adresse des Mediums, Köln (DuMont) 2001, 34-63 (41) This identification of signals happens 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.

McLuhan at the borderline of digital computing time

- McLuhan's focus on electricity blinding him to conceive the computer as a primarily techno-mathematic, algorithmic device (*aka* Turing machine); alphanumeric processuality (with its non-linear branching) escalating the analytic transformation of signals into symbols privileged by the alphabetic order, resulting in the "Euclidic control system" (McLuhan)

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

- operations of the symbolic machine called typewriter (discrete fingertips)

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

- Y2K: "There is [...] a very common method of storing in only two bytes a date from the 20th century [...]. There is also the possibility of expressing a date by counting a bit for every day (or whatever) since a system dependent fixed date. These so-called 'timer-tics' are extremely difficult to decipher if the fixed date is not known. In East German data files, many different possibilities were used to express dates or numbers" = Michael Wettengel, German Unification and Electronic Records: The Example of the „Kaderdatenspeicher“, lecture Annual Meeting of the Society of American Archivists, Washington, D.C., 2. September 1995, session 59: Bit by Bit: Perspectives on Managing Electronic Records [forthcoming in: Seamus Ross / Edward Higgs, *Electronic Information Resources and Historians: European Perspectives*, Oxford UP 1996, typescript, 5 f.

- finishes McLuhan's *Understanding Media* with a chapter on "automatization"; Jens Schröter, *Von Heiß/Kalt zu Analog/Digital. Die Automation als Grenze von McLuhans Medienanthropologie*, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (Hg.), *McLuhan neu lesen. Kritische Analysen zu Medien und Kultur im 21. Jahrhundert*, Bielefeld (transcript) 2008, 304-320
- McLuhan, with his servomechanistic concept of man-machine symbiosis, heavily referring to the cybernetic epistemology of his days, but significantly blinds out its mathematical foundation on which Norbert Wiener always insisted - a mathematization which ultimately replaced McLuhan's vision of a synchronous, instant and resonant "acoustic space" by digital calculation
- McLuhan's media theory not updated in a linear way (as understood in history of technology or in signal processing: linear signal transfer between input and output), but rather as a toolbox, opening an awareness for media-induced phenomena acting upon humans
- transforming McLuhan from a historicised media theorist into an up-to-date model by reading him in his posthumous work, that is: almost alive, as inbetween-time (almost alive, nevertheless dead)

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

- tracing tempor(e)alities in the age of media mobility: mobility associated with linear ("analog") migrations and non-linear ("digital") dislocations in topological space and time; within the *temporal* and diagrammatic dimensions of mobility in media-based communication the despotic signifier "time" itself implodes, resulting in the necessity for alternative descriptions of the dynamics within the chrono-poietical field; the plausibility of "mobility" for analysing the current condition might turn out to be an antiquated remnant of modernism which blinds the insight into the topologies, diagrams and graphs of networked (chrono-)spheres.
- "serial" time - known from television as program format - is part of the geometrization (mathematization) of time (as opposed to entropic "natural" time).
- term "mobility" lags behind; left-over from discourse of modernity (its transport systems); in "digital" present times, rather techno-mathematical topologies ("Internet traffic") and heterochronotopies
- radically new, mathematic forms of trans-temporality
- real-time computing (*aka* reactive computing) hardware and software systems which are, at the same time, subject to constraints in bitstream transfer, such as operational deadlines from event to system response. By contrast, a *non-real-time system* is one for which there is no deadline, even if fast response or high performance is desired or preferred. "A real time system may be one where its application can be considered (within context) to be mission critical"
= http://en.wikipedia.org/wiki/Real-time_computing

- term *real-time* derives from its use in early simulation. While current usage implies that a computation that is "fast enough" is real-time, originally it referred to a simulation that proceeded at a rate that matched that of the real process it was simulating. Analog computers often capable of simulating much *faster* than real-time; as critical as a slow simulation if not recognized and accounted for

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

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

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

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

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

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

The "sense of ending"

- "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 Wahrnehmung in der Moderne*, Frankfurt / M. (Suhrkamp) 1995, 47

- 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*

Gaming 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 distinction") 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)
- 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*, disrupting narrative (German "Erzählung"). 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 seduced by narrative suggestion, but to calculate in discrete states, with the consequence not to tell events intransitively but to count them transitively, quantizing data. The media theorist Lev Manovich (in a chapter of his book *The Language of New Media*) calls this the 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*.

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

- 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 metaphysics of implicitly 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 rather time-logical than culturally contextual; for an analysis of what "actually happens" (Ranke) in that *epoché*, cultural semantics transforms into sheer 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 Thermodynamics = 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 predictable 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 Bergson'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 $f(t + T_{\text{speicher}})$. 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 Mycenaean Linear B writing by Ventris) knows that it is undecidable which distortion is intended (cryptography) or physical channel noise; for a cryptanalyst, 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 equilibrium 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 exchangeable 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 "pseudoproxies", such archeo-thermal research turns informational, applying algorithms to combine proxy records into a hemispheric 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 (A)SYNCHRONICITY

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

- auditory sense "particularly adapted to perceptual anticipation in the detection of time patterns and is often so used; [...] either intensity or rhythm rather than pitch have usually been the modulation employed" = J. D. North, Application of Communication Theory to the Human Operator, in: Colin Cherry (ed.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 372-389 (386)

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

- "In the space-time world of electric technology, the older mechanical time begins to feel unacceptable"; linear perception replaced by synchronisation; different from the classical five modal human senses, enhanced by being coupled to technological agencies. "By electric tapes, synchronization of any number of different acts can be simultaneous. Thus the mechanical principle of analysis in series has come to an end" = McLuhan 1964: 152

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

- "The function of a communicator is to achieve a state of resonance with the person receiving visual and auditory stimuli from television, radio, records, etc. Decoding symbolic forms such as [...] drums, lantern signals, or written words is no longer our most significant problem. They extract meaning from perception in a manner prescribed by the structure of the 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 than 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 <sc. Platon, *Phaidros*>. [...] As stimuli, electronically mediated communication cannot be analyzed in the same way as print 'content'" = Schwartz 1974: 19

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

- critique of the notion of the "audio-visual" as such; asymmetries between the auditive and the visual in signal processing (in sensory perception which means *aisthesis* - and in technical media which means media-archaeological operations) in its different temporal configurations and eventualities ("the temporal gap", both in its techno- and neurodynamical significance); synchronization between sensory and signalling pulse trains; neuroscientific vocabulary 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

Bulova Accutron

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

- non-metaphorically, core agency of synchronization is communication between nonlinear oscillators which adjust their rhythms due to weak interaction. Literally, "emerging synchronization" has been Christiaan Huygens' 17th century observation of two pendulum clocks suspended in the same wooden beam whose motions were "so much in agreement that they never receded the least bit from each other and the sound of each was always heard simultaneously" = *Horologium Oscillatorium*, as quoted in: Michael Rosenblum / Arkady Pikovsky, *Synchronization: from pendulum clocks to chaotic lasers and chemical oscillators*, in: *Contemporary Physics*, vol. 44, no. 5 (September / October 2003), 401-416 (401). By such *coupling*, the implicit "sonicity" of synchronization (named "le phénomène de la sympathie, sympathie des horloges" by Huygens = quoted *ibid.*) becomes explicitly acoustic. "These features are typical not only of clocks, but also of many oscillating objects of diverse nature" - generalized sonicity = 402. "Mathematically, such an oscillator is described by an autonomous (i. e. without explicit time dependence) nonlinear dynamical system" (*ibid.*) = invariant in regard to "historical / cultural" time, rather *eigenzeit*. Beyond acroamatic fixation of that time-critical phenomenon to the audible by human ears, the effects was applied by E. V. Appleton and B. Van der Pol to exact triggering of vacuum tube triode generators as basic condition of radio electronics; soon afterwards in 1920, W. H. Eccles and J. H. Vicent "coupled to generators which had slightly different frequencies and demonstrated that the coupling forced the system to vibrate with a common frequency" = Rosenblum / Pikovsky: 402. Obviously, "the frequency of a generator can be entrained, or synchronized, by a weak

external signal of a slightly different frequency" = *ibid.*; *entrainment* therefore does not only relate to the adaptation of human neurons to musical rhythm.

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

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

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

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

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

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 length 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 metadata attached to microfilmed 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 technically 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 high-sensitive chronometrical measuring media, calculating the temporal delay within nerves for incoming signals; the run-time (speed of propagation) 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 *dispositif*; 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 cave 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 realized 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 *Théorie 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, phenomenologically noticeable by the physical nature of refraction - "the bedding 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, possibly multiple in times, as it existed at a previous point in time. One can sing with one's self" <ibid., 42>; change in sound propagation takes place due to diffraction - "sound turning a corner, when the edge of a barrier generates a new series of waves" <ibid., 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, possibly multiple in times, as it existed at a previous point in time" <ibid., 42>

- 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"

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

Kinaesthetics of the electronic image (with Viola)

- 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" = 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 misleading 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 main musicians even start playing, stated by the presence and count 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 harmonic series of the individual 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

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

- what appears as technical failure, turns out to be 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 electromagnetic spectrum, a sense organ for "radio" in terms of radiation; ears and eyes are completely different data processors.

- experiments 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 it 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 instruments from the late 1920s and the 1930s were based on the mechanism of a rotating disc that interrupted the passage of a beam of light between its source and a photocell [...], thus avoiding the wear and tear of direct contact with the surface of the recording

- (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 requires discreet 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 inscribed 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

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

- 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

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

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

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

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

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

- Lee DeForest, inventor of the first "electronic", that is: manipulable vacuum tube (triode) and the "Audion" radio, recalls Ernst Ruhmer's 1906/07 experiments as attempt to photograph sound vibration by means of the *speaking arc*: "Strong telephonic currents from a powerful microphone were superimposed on the direct current across the arc, producing sufficient fluctuations in the arc light to permit a crude photographic record upon a cinematograph film which was driven at a very high speed" = Lee deForest, *The Phonofilm*, in: *Transact. of the Soc., of Motion Picture Engineers* Nr. 16 (1923, 61- (61)

- in a non-linear turn the Optophone did not lead to sound film but to digital computing. This media event is to be described a-historiographically: not "from analog audiovisual aesthetics (and *aisthesis*) to digital calculation", but rather: an abstraction. "The optophone was a [...] apparatus which employed the photosensitivity of a selenium cell for converting light into sound" = Cornelius Borck, *Blindness, Seeing, and Envisioning Prosthesis: The Optophone between Science, Technology, and Art*, in: Dieter Daniels / Barbara U. Schmidt (eds.), *Artists as Inventors. Inventors as Artists*, Ostfildern (Hatje Cantz) 2008, xxx-xxx (introduction); presentation of this apparatus led London's *Pall Mall Gazette* to comment that the new approach interfered with the natural order of the senses and lead to a fundamental irritation of the human perceptual order and separation of time and space on the level of delay time (*Laufzeit*) between sound and light itself: "An ingenious Birmingham scientist has turned the element of selenium to account by making light audible, and we are to be dazzled and deafened both at once. Sunlight makes a roaring sound, and lightening, presumably, anticipates its concomitant thunder. All we require now is to increase the anticipative process, and then day light will awaken us every morning a couple of minutes before it arrives" = June 24, 1912, as quoted in: Borck 2008

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

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

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 electrophysiological 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: It takes electrophysiological high-sensitive (vacuum-tube-amplified) measure instruments to detect such phenomena; alliance between the measuring media of brain activity and their essential performance, with both relying on electric events. Only with the advent of the 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 particular sound frequency or 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 becomes even tighter, 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 vocabulary 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

- to what degree theatre and drama studies helpful to analyze the operativity of digital media; time-based character of both theatre / drama and the von-Neumann-computer architecture which links both; transform this into experimental performances which (re-)translate the sublime data processing in machines (since unrecognizable for slow human senses) into three-dimensional, audio-visual space

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 interaction 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 stage 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, Korea hskye@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) is 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 "quantizing errors" in the digital copying process) not at work; creates a different sense of time; gap between the culture which is dominated by the experience of entropy in tradition, and digital culture of controlled compression (rather than lossless) transfer

- technological media elements which at first glance look outdated but become retro-avantgarde once being deciphered with media-archaeological eyes and minds - such as a telegraphy apparatus which turns out "digital" *avant la lettre*, by-passing the age of so-called "analog" signal processing media like electric telephone; resist the melancholic impulse which is associated with so-called "dead media"; electric telegraph operates with discrete signal transmission: a code which after an age of AM media (such as radio) returned in unexpected ways

- 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 diagrammatic reading of circuit plans and material hermeneutics (media-archaeological philology); concerning source code in the case of ancient computers, name of the machine-orientated programming 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 demonstrate how the hardware to perform discrete numerical operations - nowadays almost exclusively be associated with the digital computer - has been literally transferred from a voice communication technology - just like the vacuum tube which had been invented for amplification of weak electric signals but was later "mis-used" in Flipflop circuits of early stored-program computers;

hybrid cross-overs define "the mode of existence of technical object" (Gilbert Simondon)

- specifically media-induced ways of "re-presencing" the past: technological ways of re-generating and re-storing time signals; media-archaeological focus on the conditions under which the technological past can "have 'presence' in the present" = Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333 (323); escape the romantic orientation "via the insistence on a rigorous attention to matter and machines" = Goddard 2014: 13

- 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 Iser, *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 heritage in times of communication media: model of techno-cultural "memetics" where cultural knowledge is transmitted by gene-like entities called "memes" which can be either an idea, belief or belief system, or pattern of behavior that spreads throughout a culture either vertically by cultural inheritance (as by parents to children) or horizontally by cultural acquisition (as by peers, information media, and entertainment media); a pervasive thought or thought pattern that replicates itself via cultural means; a parasitic code, a virus of the mind especially contagious to children and the impressionable the fundamental unit of information, analogous to the gene in emerging evolutionary theory of culture; memetics the study of memes; in blogspeak, an idea that is spread from blog to blog; an internet information generator, especially of random or contentless information = <http://www.urbandictionary.com/define.php?term=meme>

"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 yield 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); "optionism", 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* he wrote that the past can only be recorded as an image which

simply flashes through one's mind at the moment of its discernibility never to be seen again; 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 container, 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 materialities and corporealities into immaterialities and pure information; disintegration of the Kantian *a priori* of space and time by the technological *a priori*, in favour of speed (Virilio) and non-linear connection (Internet communication); advancing immaterialising of information; signal events caught up by recording systems in real-time; „other places“ like the museum (Michel Foucault) become nostalgic retro-effects

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

- 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 itself" = 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-fulfilling 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 critical "pixelisation" of museum paintings like Gustav Klimt (in the work of the Georgian media artist Tea Nili) or Damien Hirst's work (in the current exhibition *Pixels of Paradise*, in Paris, until March 2015)

Recirculating digital memory: the Delay Line

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

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

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

- dynamic data manipulation known from early dynamic computer "memories", such as the Acoustic (mercury-based, and other) Delay Line for re-circulating binary pulse trains, functioning as a variable, scalable temporal interval replacing the cultural idealism of eternal memory. But in a close reading, a tight coupling of temperature and memory arises: mercury delay lines are highly sensitive to temperature variation, thereby limiting or even distorting the clocked pulse trains in the intermediary memory channel. "The variation in the delay through mercury depends only on temperature" = T. Kite Sharpless, Mercury delay lines as a memory unit, in: Proceedings of a Symposium on Large-Scale Calculating Machinery, Cambridge, Mass. (Harvard University Press) 1948, 103-109 (105); what happens in storage here, true for transmission of signals as well: In echo-location by the sonar (different from RADAR based on electro-magnetic waves), which is based on measuring the $\Delta-t$ passing between sending and receiving back the ultra-sonic (thus vibrational, mechanical) signal, time-criticality becomes temperature-critical, since the speed of an acoustic signal considerably varies with air temperature