Text block "'DEEP' MEDIA TIME"

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"DEEP" MEDIA TEMPORALITIES AS ARCHAEOLOGIES OF THE RECENT PRESENT

"Outdating" media history

Media archaeology, with all its different approaches, is still united in its efforts to escape a linear notion of history of technologies, proposing alternative figurations of media-in-time instead. Marshall and Eric McLuhan describe the general *Laws of Media* (1988), as double temporal Moebius loop, in "tetrads" of

enhancement, retrieval, reversal and obsolescence, while Jay David Bolter and Richard Grusin identified "remediation" (1999) to describe the return of past media as user interfaces within the present. Siegfried Zielinski, in a historicizing turn of his former concept of media archaeology, accentuates the cross-cultural and diachronical "variantology" of technological constellations. Erkki Huhtamo's cyclical *topoi* name recurrent techno-imaginaries like the phantasmagoria in optical media[1], while Late Friedrich Kittler concentrated on the notion of "recursive" cultural techniques such as the ancient Greek alphabet with its primary unity of letter and number, which returns within computing as alphanumeric code.

Still, most of such approaches still remain within the (experimentally extended) discursive frame of the historical discourse. A concept like "historical media archaeology" (coined by Kittler) therefore is an oxymoron. While the emergence of technologies is irreducibly intertwined with historical contexts indeed, as taken care of by Science and Technology Studies, there are techno-epistemological qualities which do not unfold in historical time. Only with a non-historicist concept of technological tempor(e)alities, it is possible to interrelate different temporal layers of technology in recursive rather than linear, narrative ways indeed. Radical media archaeology understands the operative being-in-time of technologies as non-historicistic, restraining from metaphorical expressions like "to dig out secret paths in history, which might help us to find our way into the future"[2]. The archaeological metaphor of "digging" into past media grounds is misleading (unless it becomes literal in the spectacular case of unearthing the Atari *E. T.* video game cartridges which have once been buried after their economic failure). Different from redemptive rescuing of forgotten or even "dead" media like Bruce Sterling's online *Handbook of Dead Media* inaugurated 1995 ("now itself near dead in terms of activity"[3]), media archaeology, in its non-historicist analysis of the technological condition, is radically contemporary, extending the time window of the present to the geological layers which braught forth the rare earths for contemporary microelectronics today (Jussi Parikka). Like in geology and archaeological sites, technological sedimentation or layers have accumulated in deep time, but are active as radical co-presence.

Given the definition that technical devices are in a "media" *being* only when *in operation*), whatever looks like "deep" time layers hidden within technologies in the historicist sense, is suspended *in* and *by* the moment of their operation, as Hegelean *Aufhebung*, and Husserlean *epoché*.

The critique of linear media historiography is post-human, when it is articulated from within technology itself. This in turn incites alternative ways of writing (about) media time.

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1 Erkki Huhtamo, From Kaleidoscomaniac to Cyberned. Notes Towards an Archaeology of the Media, in: Leonardo vol. 30., no. 3 / 1997, 221-224

2 Siegfried Zielinski, Media Archaeology, in the online journal C-Theory, November 7, 1996

3 Kristoffer Gansing, Transveral Media Practices. Media Archaeology, Art and Technological Development, Malmö (Malmö University) 2013, 61

Any archaeological excavation always discovers the material presence, not the pastness of cultural artefacts or infrastructures. In a radical short cut of emphatic media time dimensions (aka "history"), media archaeological analysis focuses on the technological ways of re-presencing (Vivian Sobchack). By analogy, the radical media-archaeological approach is an exercise in relieving present techno-action, at least for moments, from their historical enframing.

"Historically inherited" technological knowledge, when conceived in close media archaeological analysis, turns out as an effect of techologies of cultural transmission itself. The way the technological apparatus embodies accumulated knowledge is not archival in the historical but in the Foucauldean sense of *l'archive*. Different from the preservation of its external documentary records, technical media materially and logically preserve compressed knowledge themselves, and they release their technological past into the present not narratively, but operationally. The actual micro-temporal signifier which is operational inside both analog and algorithmic technical devices here displaces the imaginary signified called "history". A vacuum tube-based short wave radio receiver from the 1950s, even after the "analog" modulation of radio signal has been switched off in public broadcasting, is still receiving electromagnetic waves such as "natural radio" from the ionosphere or even extra-terrestrial radio astronomy. Media-archaeological analysis does not negate the historical context of technological devices, but radically acknowledges that their historicity is suspended in the moment of media action.RMA's concern with operational time actually by-passes the historical discourse.

Time-invariant alphabetical coding *versus* material temporality

Against the physical (thermodynamical) world, and the biological degradation of life, with its irreversible time arrow (aka entropy), culture neg-entropically "makes sense" of existence by re-organizing time on the symbolical level of linear writing, culminating in an discursive imaginary called natural or cultural "history".[4]

The frontispiece of Lafiteau's *Moeurs des sauvages Ameriquains* (1724) shows the incommenruable encounter of writing (historiography as cultural technique, as organization of time as symbolic) and physically real time (the irreversible, materially destructive time arrow of entropy) in a space littered with relics from both Classical Antiquity and the New World. Here, the specific (a)historicity of media time unfolds. The muse of history (Clio) holds the pen, coding temporal decay into a principally time-invariant regime of letters, while the allegory of time (Chronos) carries a deadly weapon: the scythe. Both tools approach each other asymptotically without ever touching.[5] At this point a rupture between semiotics and analog media recording occurs: While symbols are timeless abstractions for notation, signals are physical beings which take place in time

4 See Vilém Flusser, Writings, Minneapolis (Univerisity of Minnesota Press) 2002

5 Michel de Certeau, Writing versus Time, in: Rethinking History, ed. M.-R. Logan / J. F. Logan, New Haven: Yale French Studies 59 (1980)

(the tempo"Real"). This Foucauldean discontinuity is directly associated with the rupture between the anlogue and the digital.

Lafitau's allegorical scenario can be translated into media-archaeological terms indeed. With programmable computers (such as Charles Babbage's Analytic Machine since 1830), the symbolical regime is not kept apart from entropy-prone material artefacts like energetic machines any more, but inscribed therein. Thereby the in/compatability of the Symbolic and the Real becomes the epistemic drama within technology, with all its escalations and frictions. Any technological artefact enacts (or defers) its irreducible double-bind between material, time-irreversible obsolescence on the one hand (the historicism of *techné*), and the principally time-invariant value of logical reasoning (alphabetic notation of articulated speech, mathematical computation, logical circuitry) on the other.

"Media archaeologies of the present" as non-historicist diagnosis of Information Society

Contemporary culture increasingly indulges in ubiquitous computing. A media archaeology of this technological present reminds of its underlying technical and logical pre-conditions. Contrary to the intuitive understanding, "media archeologies of the present" is *not* about the most recent technological events which govern our contemporary techno-social condition. The printed timeline *Tracing Information Society*[6] starts with 1900. But when do media conditions "begin"? Any "media archaeology of the recent past" finds itself in a blind spot: The *archive* of the present, which in Michel Foucault's sense is the techno-logical *a priori* of multi-media enunciation, by definition is not accessible. A media archaeology of the present refers to technological infrastructures, not to narratives, questioning the suggestive linearity of the "timeline" itself, in favor of alternative chrono-poetics such as algorithmic timestretching. Different from a linear sequence in chronological order, media-archaeological analysis zig-zags back and forth on (and against) the technopolitical "timeline" of information society, close to the actual step-wise operations of the turingmachine reading / writing head.

[In many ways, the technological option of identically reproducing the recorded signal (like in phonography) and recycling the data archive (its nonlinear digital adressability) has replaced the teleological, linear "sense" of history. While the temporal vector of irreversible time has been scientifically objectified by the Second Law of Thermodynamics (Boltzmann-entropy); this has been replaced by iteration and recurrence in the symbolical regime of informational Shannon-entropy in digital communication engineering.]

While "social media" platforms like Facebook, Twitter, and Instagram have long been functionally and visually organized on the explicit "Timeline", this chronicle-like symbolical order of time is displaced by the Newsfeed algorithm, a dynamic cluster of different factors or coefficients structuring the representation of events, while with the instant messaging service Snapchat, recorded events become visible for a fraction of time only; the present

6 http://www.technopolitics.info/Timeline

becomes ephemeral again. But in global communication networks, the time zones still rule.

A linear timeline misses the complex non-linear constellations which redefine the "recent" technological past. According to Walter Benjamin's *Theses on History*, the past "flashes" into the temporal now ("Jetzt-Zeit"). In reverse, the "Now" becomes antiquity almost immediately. The contemporary condition dates back to basic, recurrent technologies which are *recent* in the literal sense. German "rezent", as defined in the dictionary, in the biological context means "gegenwärtig [noch] lebend, auftretend oder sich bildend"; in Austrian use of speech, "rezent" means "zeitgenössisch, aktuell, vor Kurzem entstanden."[7]

Digitization means archaeologisation in the sense of mathematising the present. The Instant Archaeology Concept, connecting computer data bases with digital editing, has been developed by Michael Mikina and Francis Wittenberger for Digitale '98 festival at the Cologne Academy of Media Arts. The video material during the festival was recorded in a away that allowed for an individual editing in real-time.[8]

[Critical analysis of the supremacy of historical discourse in the cultural conceptualization of times past, like Hayden White's *Metahistory*, has reminded of non-historic perception of temporal realities which has been practiced in culture already, such as early Mediaeval forms of registering events. Such Annals, different from chronicles and historiography proper, convey a way of experiencing reality not in terms of continuous but in discrete time.[9] With there formal listing of events they are close to state-based automata with their discrete writing / reading of symbols on an endless memory tape - a concept which is, of course, the diagram of the Turing Machine).]

Further entries into the "Time Line"

The escapement-driven clock: The invention of the escapement-driven clock is non-dated. The historian of culture insists: "A timepiece is much more than a mechanism. To attempt to understand it in isolation from its human setting is to forget that it was made in the first place in response to specific human needs."[10] But when such a mechanical clock is in operation, its functions depend on a genuinely media-governed logic which is at work indifferent to its application in a medieval monastery of the past or a museum of the present. The message of the media mechanism is not only the acoustic signal which is

7 http://www.duden.de/rechtschreibung/rezent; accessed October 27, 2016

8 On the concept of "instant archaeology", see Siegfried Zielinski, (An-)Archive. Die Abschaffung der Gegenwart und das Archiv der Zukunft, in: Bernhard Serexhe (ed.), Konservierung digitaler Kunst: Theorie und Praxis. Das Projekt digital art conservation, Karlsruhe (ZKM) / Wien (AMBRA) 2013, 95-113 (100)

9 Hayden White, The Value of Narrativity in the Representation of Reality, in: Critical Inquiry vol. 7 no. 1 (autumn 1980), 5-27

10 J. D. North, Monasticism and the First Mechanical Clocks, in: J. T. Fraser / N. Lawrence (eds.), The Study of Time II. Proceedings of the Second Conference of the International Society for the Study of Time Lake Yamanaka - Japan, Berlin / Heidelberg / New York (Springer) 1975, 381-398 (381)

decoded by human ears as an indicator of temporal measurement, but as well a media-physical reminder of frequencies and oscillations, rhythm and repetition - basic media-archaeological ingredients in the study of nature. The coming-into-being of the mechanical escapement which (apparently from the 13th century) is the new media-epistemological feature of the mechanical clock in the strict sense is as much bound to moments of cultural history as it is bound to techno-logical laws which operate in an an-historical temporal regime, and its "tradition" is as much a function of survival of knowledge on (especially astronomical) wheel-driven clocks (astrolabs) from antiquity to medieval times as it is part of a techno-logical self-reference which is only partly identical with discoursive variations of human history. The decisive mechanism which distinguishes the "truly mechanical clock" (J. D. North) from traditional astronomical mechanisms is the verge or foliot escapement (such as Giovanni de´Dondi clock) which is later being replaced by the pendulum. Periods of swing (oscillations) which had been cultural knowledge as long as it was restricted to observation of planetary systems for agricultural use all of the sudded became a fundamental parameter for micro-temporal events, opening my media-operative measuring devices insight into a world of time-critical operations unknown to human perception (*aisthesis* / aesthetics) before. Media archeology does not extend its ambition to explain the ways in which an oscillatory mechanism for both measuring time and striking a bell in the thirteenth century "was obsorbed into the high ritual of the church" and why this was "fitting"[11]; the canonical hours of the monastic life - especially in the Cisterian rule where Rule XCIV ask both for *horologium temperare* and *facere sonare* - almost inevitably asked for automatic control sooner or later, but the other driving energy for the development of the mechanical clock, the desire to cause a clock to sound on its own, operates on a level which is closer to science than to religion. Parallel to this cultural logic, something else is at work; media archaeology rather pays attention to the fact that below this apparent cultural use something was established on a level sub-conscious to culture and religion: a training of sensibility to micro-temporal events. While the essence of sound had been a favourite topic of analysis in early Greek philosophy and musicology (from Pythagoras onwards), its media-technological reproduction by oscillatory mechanisms follows a logics of its own. At this cross-road between culture and physics media archaeology steps in.

Fourier transform: In terms of a media archaeology of the present Information Society, Joseph Fourier's 1822 *Theory of Heat* provided for the mathematical condition of techno-mathematical Digital Signal Processing. Fourier Transform converts a mathematical function of time into a new function whose argument is frequency counted in cycles per second (hertz)[12], thus transforming the time domain of a signal into its frequency domain which is discrete numerical values. Discrete-time Fourier Transform facilitates digital storage and computation of physical (real-world) signals and their replay, since the operation can be reversed from the frequency domain back into the time domain. Such high-fidelity reconstruction of signals is not simply essential for audio and video reproduction technologies today, but for inquiries into the non-historical nature of media tempor(e)alities as well. The Moebius loop like entanglement between the time and frequency, between analogue vibrations

11 North 1975: 393

12 en.wikipedia, "Fourier transform", accessed September 27, 2013

and discrete numbers, is the essence of a time machine which is physical and symbolic at the same time: *algorhythmics*[13].

In 1965, James Cooley and John Tukey published a paper "re-inventing the algorithm of Fourier Transform and describing how to perform it conveniently on a computer."[14] Against its suggestive expression, Fast Fourier Transform is not simply an escalation of computational speed but resulted in a new object of knowledge in terms of Process-Oriented Ontology. FFT has been included in the Top 10 Algorithms of 20th Century by the IEEE journal Computing in Science & Engineering.[15] In principle (*en arché*), this algorithm, including its recursive application, was implicitely invented around 1805 by Carl Friedrich Gauss, who used it to interpolate the trajectories of asteroids. Published only posthumously, the recipy of Gauss' asymptotic computational time remained in latency; still it is implicitely operative in present ubiqutous computing. At that point, the suggestive timeline actually *mis*represents the archaeology of media knowledge.

Cinematography: Media history usually dates cinematography back to 1895, with its first public screening (*The arrival of a train*) in Paris by the Lumiére brothers. But this vintage drama is not historical; in way, the train arrives again. In recent years, the "post-digital" in media art has been announced, such as the "archaeological" use of anachronistic media like early 16mm film - a retro-effect of temporal snapshots against digital atemporality, an archaic counter-practice.[16]

The turingmachine, 1936: The timeline becomes operative when conceived like the "tape" of the Turing machine, scanning the entries and removing them back or forth as a function of the media-archaeological "program" table of media-archaeological reasoning. The very entry 1936 (Turing, "On computable numbers") will thereby transform into a write/read operation of the turingmachine itself : "Das Medienzeitalter, im Unterschied zur Geschichte - die es beendet - läuft ruckhaft wie Turings Papierband. Von der Remington über die Turing-Maschine zur Mikroelektronik, von der Mechanisierung über die Automatisierung zur Implementierung einer Schrift, die Ziffer und nicht Sinn ist [...]."[17]

The turingmachine scans an entry in a square from the paper tape, which in combination with the instruction by the command list results in a specific "m-configuration" at a given time[18]. "These events occur only at discrete 'moments' - between which nothing happens [...] like the ticking of a clock

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13 Shintaro Miyazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012, http://computationalculture.net

14 https://en.wikipedia.org/wiki/Cooley%E2%80%93Tukey_FFT_algorithm (3-11-16)

15 https://en.wikipedia.org/wiki/Fast_Fourier_transform, accessed November 3rd, 2016

16 See Malin Wahlberg, A Relative Timetable. Picturing time in the era of new media, in: John Fullerton / Jan Olsson (eds.) 2004: 93-103

17 Friedrich Kittler, Grammophon - Film - Typewriter, Berlin (Brinkmann & Bose) 1986, 33

[...]."[19] This is symbolically ordered temporality, a kind of chrono-photographical apparatus where the read/write head takes snapshots of the turingmachine state. In return, this symbolic mechanism can equally be instanciated by a mechanical one, actually calculating with a crank. Emil Post's definition of effective calculability as *a worker mindlessly following a list of instructions* to move left or right through a sequence of rooms (reminding of Searle's "Chinese Room" model for artificial intelligence) and while there either mark or erase a paper or observe the paper and make a yes-no decision about the next instruction"[20] - an existance in discrete states.

Such kind of operation corresponds with the early Mediaeval form of registering events. The Annalistic writing system (as opposed to chronicles and historiography proper) conveys a way of experiencing reality not in terms of continuous but in discrete time[21], closer to state-based automata with discrete writing / reading of symbols on an endless memory tape (the diagram of the Turing Machine).

A media archaeology of the present is not only nonlinear (in the sense of Manuel DeLanda's proposal *A Thousand Years of Non Linear History* (1997), but even non-human. Providing insights into the non-human nature of technological tempor(e)alities is a specific interest of media archaeological sense of time.[22] "Media cross one another in time, which is no longer history"[23], but rather re-entries of past technologies within the new.

In June 21, 1918), Eccles & Jordan *implicitely* invented the vacuum-tube based trigger circuit or multivibrator as circuitry which only retrospectively is identified as the "first" flipflop circuit, the basis for binary electronic memory. Independently, in the early Soviet Union, Bonch-Brujevich in 1919 defined the same electronic coupling for radio signal transmission.[24] Such co-originality expresses a non-linear temporality of techno-logistical coming-to-articulation, subverting the timeline. Instead of a linear history of technologies, there is diagrammatic "path dependency" in technical individuation rather than the

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18 William Aspray, John von Neumann and the Origins of Modern Computing, Cambridge, Mass. / London (MIT Press) 1990, 176

19 Marvin L. Minsky, Computation. Finite and infinite machines, Englewood Cliffs, New Jersey (Prentice-Hall) 1967, 12

20 Entry "Algorithm", https://en.wikipedia.org/wiki/Algorithm, accessed January 16, 2019, referring to: Emil Post, Finite Combinatory Processes – formulation 1 [1936], reprinted in: Martin Davis, The Undecidable: Basic Papers On Undecidable Propositions, Unsolvable Problems and Computable Functions . New York (Raven Press) 1965: 289–290

21 Hayden White, The Value of Narrativity in the Representation of Reality, in: Critical Inquiry vol. 7 no. 1 (autumn 1980), 5-27

22 See Michael Goddard, Opening up the black boxes: Media archaeology, 'anarchaeology' and media materiality, published 28 April 2014 in: New Media & Society, http://nms.sagepub.com/content/early/2014/04/27/1461444814532193

23 Friedrich A. Kittler, Gramophone, Film, Typewriter, Stanford, CA (Stanford University Press) 1999, 115

24 See Nitussov / Trogemann / Ernst (eds.), Computing in Russia, Braunschweig (Vieweg) 2002

linear timeline historiogram of technical evolution. If the analysis of information society is meant to be "traced" rather than narrated, media archaeography is required. There are temporal modalities, or time-scales, which escape the timeline, such as cyclical patterning of “techno-economic paradigms"[25] (so-called Kondratieff waves). Cultural experience and techno-aesthetic discoveries may be "out of sync", in relation to such long wave patterns of around 50 years. The concept of technological nonlinear "path dependency" (as applied by Pinch / Trocco in their synthesizer-book *Analog Days*) recalls Fernand Braudel's triad of temporalities (immobile history on the geological or climate level, the *longue durée* of cultural time, and finally the event level. Media have their own time and temporality, rather in self-stabilizing intervals than as linear unfolding.

Between remake and re-mediation (Bolter / Grusin 1999), certain technologial media apparatus and artefacts sometimes reoccur; historicizing media analysis accentuates this *discursive* force, whereas media archaeology lets the non-discursive real of such processes speak. Media historiography semanticizes technological events, while media archaeology is the articulation of the indexical trace.

Telegraphy, for example, is not an outdated communication technology from the nineteenth century; beyond its obsolete technical implemenation in cables and electro-magnetic relays, its endurance is the "digital" *avant la lettre*, different from analog radio and television signal transmission inbetween.

Discrete time signal processing has been implemented in electronic modules such as the sample and hold circuits, analog delay lines, and analog feedback shift registers as predecessors of digital signal procesing. There is a current re-entry of analog computing as mathematical modelling. An analog computer, modeling a real physical system, uses its physical quantities to represent the behaviour of another physical system, or mathematical function.[26] Even if it is obsolete in techno-historical terms, the analog computer media-archaeologically re-occurs in quantum computing, thereby questioning the linear timeline.

In 1996, being aware of the accelerating obsolescence of Web pages in the Internet, Brewster Kahle started the Internet Archive http://www.archive.org which soon provided for a symbolic time machine: the Wayback Machine, implemented in 2001, which for an Internet address (URL) presents a chronologically ordered list of links to the same web page at different times.

The domain name www.youtube.com was activated on February 14, 2005; *YouTube* has since become the substitute for a missing audio-visual "library" of the WWW (no "archive").

The current Internet may be associated with previous communication networks like the horse-based postal system of the Persian empire (Innis, *Bias of Communication*) and the telegraph network in nineteenth century, a

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25 As expressed in Michael Century's forthcoming book on experimental media culture in Canada 1968-90 (contracted for publication with MIT Press)
26 See http://en.wikipedia.org/wiki/Analog_computer, accessed April 2007

reconciliation of the high-technological present to the cultural past; radical archaeology of communication media concentrates on the non-linear discontinuities which challenge even the human as central agency of such processes. Paul Baran's proposal for packet switching distribution in the US military digital ARPAnet makes the decisive conceptual difference. Media archaeology is both about identifying the logical precondition and the actual escalation of such constellations.

Questioning the "Time line"

Let time "finally" fold the timeline upon itself, like a Moebius loop. The first timeline has been a diagram designed by the founder of graphical methods of statistics William Playfair, an engineer and political economist. the line, area and bar chart of economic data. Playfair's trade-balance time-series chart has been published in his Commercial and Political Atlas, in 1786.[27] But instead of being an external function of linear time, technology since has auto-poietically generated its own "time axis" as differential signal in every oscilloscope to measure electrified time signals.

There is no time in a graphical timeline; this is a geometric spatialization, a visual suggestion of one-directional sequences of events. Temporal processuality is claimed here only symbolically, different from any physical or technical signal. In the physical world, the time axis is synonymous with the one-directional "time arrow" as defined in 1927 by Arthur Stanley Eddington.

With technological operations, we are actually within time, not in simply symbolic "historical" time. Symbol time returns with informational entropy.

The Berlin Technopolitics Salon *Media archeologies of the present* primarily referred to "Dinge die in den letzten 20 Jahren passiert sind" (Armin Medosch); in a parallel Transmediale project, the present even extends to "100 years". The timeline is supplied with names, years, and subject headings. But the media-archaeological question is not primarily about "beginnings" and moments in the historic timeline, but rather the crucial epistemological and structural moments and momentum worth to be identified and analyzed.

Google's N-gram viewer searches the full texts of some 15 million books for semantic terms and plots their frequency over a timeline. Alternatives to the linear concept of a techno-political timeline are foldings and recursions in the sense of McLuhan's *Laws of Media* ("Tetrads"); non-linear time is expressed as well in the Nyquist-criterium of physical equilibrium and the "chaotic" oscillations in the Chua electronic circuit; sociology of technology knows the diagramatic model of path-dependence. "Recursions fold time and thus enable direct contact between points and events [...] that are separated when history time is stretched out on a continuous line."[28]

In a "Timeline" of storage techniques from A.D. 77 to 2014[29], the chronological

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27 https://en.wikipedia.org/wiki/William_Playfair, accessed Nov 3, 2016

28 Winthrop-Young, op. cit., note 5

29 http://www.computerhistory.org/storageengine/timeline

axis is a conservative order; US computer industry privileges the linear outlook into an increasingly powerful future of storage media, instead of admitting the aporetic dead-end of Moore's Law ca. 2030. Moore's Law, the observation that the number of transistors in a dense integrated circuit doubles approximately every two years, has been formulated in 1965 to define the growth of processing power and memory capactiy in micro processors, in graphic expression on a timeline is a logarithmic function. The timeline of Information Society as archaeology of the present should be Janus-faced, anticipating the "future in the past" (*futurum exactum*) already for around 2030 as dead end. Gordon Moore, the co-founder of Fairchild Semiconductor and Intel, in his paper described a doubling every year in the number of components per integrated circuit; in 1975 he revised the forecast to doubling every two years. The very condition for Information Society has a sense of its own ending.

Nonlinear, rather "epochal" media-archaegraphy is resistance against the narrative-linearity which seduces to interfere with biographical data by the spectator.

How do you draw time?", Rosenberg and Grafton ask in their 2010 study. The answer is on the micro-computational level. Here, contemporary information culture has the means to actually cope with temporal complexity. The "time line" concept which started with Playfair in eighteenth-century but is an out-dated way of symbolically reducing temporal complexity (Koselleck, Luhman) to linear history. The timeline as info-graphics on display here explicitely is a print-out on paper; this affords physical space experience; the time of reading can be controlled by the visitor him/herself like a museum walk, different to externally defined video streaming. The timeline privileges the visual cognition of techno-temporality; an alternative option is a truly time-based form of knowledge access: sonification, by parameter mapping of the data entries.

A complex interrelation between the components of the "Tracing Information Society" installation has been proposed by the "dynamic-abstract" diagrams developed by Doron Goldfarb with algorithms and codes: the data-aesthetics of Digital Humanities, allowing for *n*-dimensional analysis rather than focus on one-dimensional time line. Instead of the graphically linear time, an interactive diagram allows for "diffractive time" (Paula Barad).

Traditional stratigraphic time "exhibits succession but not duration"[30], but the more advanced so-called "Harris matrix"[31] for archaeological excavation of cultural sites puts emphasis on differential series rather than on geological layers. The temporal evidence for data on computer hard drives and storage media is flat and rather archaeo-*logical* in the strict sense. It requires special software for an artifical chronological listing as "timeline" of all activities which have been enacted on such a data carrier, based on the analysis of file systems, log- and registry informations.[32]

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30 V. G. Childe, A Short Introduction to Archaeology, New York (Collier Books) 1962, 30

31 E. C. Harris, Principles of Archaeological Stratigraphy, London (Academic Press) 1979

32 See http://www.sleuthkit.org

David Gelernter's candidate for replacing the current desktop metaphor is called "Lifestreams"[33]. Since December 15, 2011, the "timeline" has been the order in which all the content of Facebook users is organized and shown. But within the computer, the reading / writing head of a Turing machine only apparently "inscribes symbols one by one in an infinite string, giving rise to time as a sequence-stream, exactly as in classical mechanics."[34] But the turingmachine memory tape itself, moving back and forth, has replaced the linear timeline.

Media archaeology is time-reversed analysis. Rather than nostalgically looking back to "dead media" as the fossils of past technologies, it attempts epistemological reverse engineering – a taking apart of contemporary technologies to see in them temporal superimpositions. Techno-logical traces of the past, in the current hardware conditions, are polychronic assemblages of past technical solutions with have actual effects on (literally con-temporary culture. Media technology does not ask for external discursive narrativization any more, but itself exposes its knots or folds of technical developments in its layers of engineering. Rather than being seduced by a linear, narrative timeline, attention for such unexpexted moments is invited *from within* such technologies.

"Tetrads" and resonance: McLuhan's alternative media historiograms

Marshall McLuhan and his son Eric figure as co-authors of a final work which claims an encompassing theory of media (in) time: *Laws of Media*.[35] The sub-titel of this work ("The New Science") explicitely refers to Giambattista Vico's model of recurrent states in cultural history; for media history, McLuhan calls them "tetrads", graphically expressing the dis- and reappearance of hidden or unnotified qualities of technologies in culture.

With all his sometimes stupifying imprecisions in media analysis, McLuhan had a stunning sense for alternatives to media historiography as linear narrative of technologies or cultural history. These alternatives do not result from distant reflection but from media themselves.

"Just as linear history begins with writing, it ends with TV."[36] In the 1954 version of Marshall McLuhan's pamphlet *Counterblast* the "Media Log" is explicit: "Sigfried Giedion has had to invent the concept of an 'anonymous history' in order to write an account of the new technological culture."[37] In another version of the pamphlet McLuhan declares: "Just as there was no history when there

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

34 As summarised by Francisco J. Varela, The Specious Present. A Neurophenomenolgy of Time Consciusness, in: Jean Petitot / same author / Bernhard Pachoud / Jean-Michel Roy (eds.), Naturalizing Phenomenology. Issues in Contemporary Phenomenolgy and Cognitive Science, Stanford (Stanford UP) 1999, 266-316 (268)

35 Marshall McLuhan / Eric McLuhan, Laws of Media. The New Science, Toronto / Buffalo / London (Univ. of Toronto Press) 1988

36 Marshall McLuhan, Counterblast, New York (Harcourt, Brace & World) 1969, 122, as quoted in Bexte 2008: 332

was no linear time sense, so there is post-history now when everything that ever was in the world becomes simultaneously present to our consciousness."[38]

Illustrative of such resonant media reverberations (though paradoxically taking place in a static spatial image form) is the mural painting in McLuhan's seminar room at Toronto university campus, René Cera's allegory of electroinc television *Pied Pipers All* (1969).[39]

Fig.: xxx

Since the dominant mass medium of his age, television, has been McLuhan's research-guiding medium, it is from the time-critical nature of the electronic image that McLuhan derives his insight into the radically temporal message of high-technological media: "You are drawn into that tube, as an inner trip. You're totally involved. You have no objectivity, no distance. And it is acoustic. It resonates. But this is a hidden ground, because superficially people think the're looking at a visual program. And they're not. They're not looking at all - they're absorbed, involved in a resonating experience."[40]

But today, such formerly "acoustic" TV images consist of digital pixels (different from the cathode ray "mosaic" of the iconoscope as referred to in McLuhan's times).

In terms of analyzing current computer-based media culture, McLuhan's electricity-centered approach seems antiquated. But when it comes to apply his critique of technical communication to the re-thinking of media history, the replacement of scriptural linearity by "sonic" resonance becomes productive. "Resonance" is McLuhan's central figure of dynamic temporality taking place in acoustic space which is "organic and integral, perceived through the simultaneous interplay of all the senses", a kind of "echoland"[41] - sonic time rather than history.

Electromagnetic signals are capable to evoke almost immediate effects in a resonant receiving system. Resonance compares to the dynamic tempor(e)ality of the electro-magnetic field rather than to the monodimensional transmission in a linear channel. Such interpretations of electronic communication which intermediates between humans expressively refer to the non-linear epistemology of the sonic temporal field[42] and thus provide a model for non-historic ways of writing media time. In a benevolent re-reading, McLuhan's

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37 Recently re-published on occasion of the media arts festival *transmediale.11* in Berlin (in cooperation with Gingko Press) in 2011

38 McLuhan 1969: 122

39 Photographic colour reproduction in: de Kerckhove et al. (eds) 2008: 331

40 McLuhan in interview with Jerry Brown, in: The CoEvolution Quarterly, Winter 1977/78: Letters of Marshall McLuhan, selected and edited by Matie Molinaro / Corinne McLuhan / William Toye, Toronto / Oxford / New York (Oxford UP) 1987, 177

41 Marshall McLuhan, The Playboy Interview: Marshall McLuhan, in: Playboy Magazine, März 1969; reprint in: Eric McLuhan / Frank Zingrone (eds), The Essential McLuhan, London (Routledge) 1997, 233-269, www.columbia.edu/~log2/mediablogs/McLuhanPBinterview.htm

42 "In watching television, our eyes function like our ears": Schwartz 1974: 14

notion of the "tetrad" suggests a diagrammatic media archaeology dealing with recursive reconfigurations.

Artists, in their time, function as "the antennae of the race" who "had tuned in to the new ground and begun exploring of discontinuity and simultaneity"[43]. This is not meant metaphorically, but uses terms of radio technology. They quote from T. E. Eliot's 1917 essay on "Tradition and the Individual Talent" where what Eliot named *historical sense* is - in McLuhan's paraphrase - the awareness of a "resonant interplay". According to Eliot, the whole of the literature of Europe from Homer "has a simultaneous existence and composes a simultaneous order"[44]. Instead of historicism, this is a sonic model, a superimposition of wave forms which are distant in terms of historical time but immediate to each other media-archaeologically. This modality is genuinely con-temporary, a "resonant interval" - an expression which McLuhan once borrowed from quantum physics. At that point, this is media theory no more.

Undermining the "timeline": Timestretching

It has been in musical notation (since Guido of Arezzo) that a symbolic "timeline" has been introduced which is quantized by interval marks of beats, with the notes on the y-axis being a function of the non-variable *t* which is the x-axis. Etymologically, *timing* itself means "dividing". The sonic "present" itself, taken at face value, becomes subject to micro-temporal manipulations. Karlheinz Stockhausen started his tonal compositions by phase-shifting of electric signals in the sonic "time field"[45].

The apparent linearity of time had already been irritated by Muybridge's and Marey's chonophotographical sampling of micro-temporal moments; temporal zigzags provided composers like Paul Hindemith with paradigms through which to explore the manipulation of both time and motion as infinitely divisible properties - the master paradox of Zeno's arrow as discussed film-critically by Henri Bergson in *L'Évolution Créatrice*. Hindemith's one-act opera *Hin und Zurück* (1927) plays with conceptions of temporal reversal. The music, running forward and backward, evokes such time axis manipulation.[46] *Online*-navigation in data bank, nowadays, leads to a permanent " re-programming" of the temporal entries ("Zeitstellen") on the historic timeline."[47]

A micro-"archaeology of the present" has been in(tro)duced by signal processing. Different from a linear timeline, the "time series" (Norbert Wiener) has become the central feature of signal analysis of the cybernetic present.

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43 McLuhan / McLuhan 1988: 47

44 T. S. Eliot, Selected Essays, quoted in McLuhan / McLuhan 1988: 48

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

46 David Trippett, Composing Time: Zeno's Arrow, Hindemith's Erinnerung, and Satie's Instantanéisme, in: The Journal of Musicology, vol. 24, issue 4 (2007), 522–580 (paraphrased abstract)

47 Wolfgang Hagen, "Being There!" Epistemologische Skizzen zur Smartphone-Fotografie, in: Bildwerte. Visualität in der digitalen Medienkultur, transcript Verlag, Bielefeld 2013, 103-131

Once sound or light waves have been transformed into frequency values, computable reality results in "a quantifiable, nonhuman time"[48]; signal processing is independent of the narrative time line. "It is only with multimedia interface metaphors that the timeline has re-entered into computational space.

A further, "final" proposal points to limits of the visual timeline graphics itself, to be replaced the temporalities of "acoustic space" (McLuhan). Time warping and rhythm manipulation such as introduced in the audio engineering software packet Ableton Live, time stretching and time compression as introduced with the ACAI sampler, are operations introduced into audio engineering with the arrival of the digital sampler since the late 1980s. The sonic present can since be extended to the immediate past as "retention" or future as "protention" in Husserl's phenomenological terms, thereby technically emulating the human "inner sense of time" itself. While with the firmly inscribed phonographic groove of analog recording as material micro-timeline, changing pitch without affecting speed has been impossible, sono-poetical algorithms now allow to dis-continue the apparent temporal flow of time itself - resulting in an aesthetics of loosely coupled time as a key feature of our contemporary media condition.

TECHNOLOGIES OF CULTURAL HERITAGE: "COLD" STORAGE, "TIMELESS" CODES

The exhibition *[Sound] Listening to the World* presents the century-olde Berlin *Lautarchiv* and *Phonogrammarchiv* [49] as an impressive collection of phonographic recordings for linguistic and music-ethnographic research. While in 1999, the recordings of the *Phonogrammarchiv* have been included in the UNESCO inventory of immaterial cultural heritage, representatives of the native American Navajo tribe question the legitimacy of such historic collections, and demand the silencing or even destruction of the ritual song recordings by music ethnologist Georg Herzog between 1929-32. The ceremonical function of the Navajo songs is not compatible with the concept of "cultural heritage" at all.

Once set apart from its ethically sensitive issue, when viewed from a media archaeological point of view, there is a medium message in this debate, since a direct link between the concept of cultural heritage and technological recording is apparently taken for granted here. If the focus is on the techno-logical rather than logo-centric conditions of such a debate, the primary driving force of the Berlin *Lautarchiv*, Erich Moritz von Hornbostel, comes into the discussion. His essay on *Phonographische Methoden* for music-ethnological research (1930), explicitely insists on the production of galvanic negatives of original recordings on Edison cylinder, to turn such musical heritage which UNESCO classifies as "immaterial" into an enduring one.[50]

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48 Kittler 1999: 170 f.

49 Humboldt-Box, Berlin, March to September 2018

50 An explicit argument in Rudolf Müller / Johannes Müske, Vagabundierende Klänge. Die institutionelle Inwertsetzung von Volksmusik-Sammlungen und die Entstehung von Cultural Heritage, in: Ruth-E. Mohrmann (ed.) , Audioarchive. Tondokumente digitalisieren, erschließen und auswerten ,

Cultural heritage increasingly needs to be addressed in technical terms indeed. Generations later, the Society of Applied Informatic in Berlin-Adlershof (GFaI) has developed a technique for the non-invasive scanning of such negative sound records, combining high-sensitive mechanical sensors with optical scanning, subsequent digital sampling and final algorithmic improvement of the signal-to-noise ratio of the derived sonic signals. All of the sudden, it is only the technological apparatus itself which grants access to such cultural heritage:

Tradition in technical terms: Transmission across space / storage over time

Usually communication across spatial distance, from telephony to electro-magnetic waves, is immediately exhausted after signal transmission and decoding by the receiver. When cultural articulation is intended to be communicated to future generations, though, the channel of transmission becomes "suspended" or "frozen", that is: storage time, by a techno-conceptual switch: the signals require material embodiment for endurance. Both modes, "transmission" and "storage", can be formulated as extreme formulations of one and the same techno-logics of communication engineering.

["Bei der technischen Speicherung ist keine Übertragung vorhanden. Mit einem Aufzeichnungsvorgang wird stattdessen das Signal, der Informationsträger als unveränderlicher Zustand fixiert" - except physical entropy. "Zu irgendeiner späteren Zeit wird er dann wieder aktiviert und kann fast genauso wie bei der Übertragung genutzt werden"[51] - just as books in a national, that is: archival library are not kept for immediate consumption, but for later reference, which - in terms of communication engineering - increases their potential of information value in a future moment of reading.]

Tele-communication across spatial distance takes place in the more or less synchronous temporal mode (real-time), while the tradition of knowledge is remarkably asynchronous (postponed, "delayed transfer" in terms of Jack Goody) - the "postal letter" paradigm of humanistic knowledge exchange. So far, cultural heritage concepts have concentrated on redundant (secure) transmission. But in terms of communication theory, the degree of information increases with improbability and belatedness.[52]

Jurij Lotman once defined culture as non-hereditary memory, achieved by neg-entropic agencies of ordered preservation: libraries, archives, museums. Only coded transmission is hereditary in the "genetic" sense by time-invariant

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Münster (Waxmann) 2014, 75-84 (77)

51 Caption to Fig. 5.1 (storage diagram) in: Stefan Höltgen (ed.), Medientechnisches Wissen, Berlin / Boston (Walter de Gruyter) 2018, vol. I (Logik, Informations- und Speichertheorie), part II "Informations- und Speichertheorie" by Horst Völz, 149-282 (218)

52 Warren Weaver, Recent Contributions to the Mathematical Theory of Communication, in: Claude E. Shannon / same author, The Mathematical Theory of Communication, Urbana, Ill. (University of Illinois Press) [*1949] 1963, 1-28

symbols (be it alphabetic, be it the alphanumeric code). In that sense Alfred North Whitehead could characterise the European philosophical tradition in terms of the book machine: "[i]t consists of a series of footnotes to Plato."[53] From that derives a split paradigm for the preservation of cultural heritage: Whereas coded knowledge can be transferred from one material carrier to another storage medium (like parchment and the printed book) without essential loss of information, technical signal recording is highly dependent on its technically specific medium idiosyncaries.

[Deferred tradition of knowledge: letters]

The basis for symbolically coded communication and cultural tradition, for the longest time in occcidental history, have been alphabets. The literary genre of "ghost talk" in European Humanisms and Renaissance (Macchiavelli, Petrarca) has been as a genuine function of writing systems. Script-based society trusts into the possibility of storing intellectual energy in writing which can be synchronically reactivated across time by reading.[54]

"Once writing is defined as a symbolic trace in a receptive material, signs are perforce transmitted through a technological interface."[55]

The printing revolution created a reconfiguration of alphabetic knowledge. The function of the interface is *coupling*. A loose coupling would still be identifiable as „medium“, according to Fritz Heider, and the tight coupling freezes into „form“.

The term *communication* usually points to oral communication, automatically thought of as a two-person game. "This may extend to letter writing. For printed communication, however, it is completely inadequate."[56]

"By letter we may absence make / even presence selfe to be. And talke with him, as face to face, / together we did see" (William Fullwood, The Enemie of Idleness, 1582). In letter-based communication, the partners have always been aware of the temporal delay when taking a letter into their hands; such delay tends to be effaced in "live" tele-communication. For the telephone, the answering machine has been a *re-entry* of the postal message - *Voice-Terminal-Echo* (Jonathan Goldberg).

Agencies of cultural transmission across time

Institutional "techniques" of cultural tradition such as archives, libraries, and museums, have escalated (or even imploded) into autonomous machines. Different from "hot" historiographical imagination based upon texts, the

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53 Alfred North Whitehead, Process and Reality [*1929], Free Press edition 1979, 39

54 Aleida Assmann 1999: 124

55 D. N. Rodowick, An uncertain utopia - digital culture, in: Claus Pias (ed.), Medien. Dreizehn Vorträge zur Medienkultur, xxx 1999

56 Luhmann 1992, xxx

mechanisation of the library itself as container of alphabet-based knowledge resulted in literal "cold storage", which is the title of a YouTube video produced by MetaLab, Harvard University on the infrastructure of its library, inspired by Alain Resnais' film on the National Library in Paris *Tout la Mémoire du Monde*.[57] The technological focus on the decisive conditions of tradition is rather microscopical than on emphatic historical contexts; temporal distance is compressed to immediacy in the symbolic regime. Just like Walter Benjamin, in his essay on "The Work of Art in the Age of Reproduction" (1936), defined the "optical unconscious" which is revealed only by the photographic lense, the media-epistemic microscope turns the analysis of cultural transmission techniques into a laboratory practice which itself depends on technologies of detection.

[The return of matter and energy within information storage: physical conditions for signal and data storage]

In terms of media ecology, there is significant energy costs for maintaining cultural heritage in memory institutions such as archives for unique records and libraries for textually coded knowledge on the one hand, and museum for materialities of culture.[58] At that point, the Norwegean National Library comes in, with its two bodies of memory: conventional books on the one side and technological records on the other - resuting in a split between logical *versus* physical preservation.

[Increasingly, any contemporary study of technologies of cultural tradition is confronted with the criterium of its ecological impact, the "anthropocenic" issue of hardware consumption and computational energy costs. The embodied energy of museum collections (as memory-accumulators), its "mnemic energy" (as applied by Aby Warburg for cultural transmission, derived from Richard Semon's term for neuronal memory) turns technological; the infrastructure of memory itself becomes an "media ecological" issue in both McLuhan's and environmental studies sense. The focus on the material and energetic factors in museum heritage corresponds with the media-archaeological focus on hardware and and techno-logical infrastructures.]

In the museum, the endurance of physical artifacts is incommensurable with their digital existence in data centers, in terms of temperature, humidity, energy use and embodied energy. Physical and / or informational "entropy" clash. Technicians at the Mo i Rana branch of the National Library of Norway take care of analogue media memory in the physical entropy sense kept inside a montain, while the digitization department takes care of the material book, photography, film, audio, video and Internet Norwegean memory in the informational sense. Within computational culture, especially Google's or "virtual stock market" server farms, the divide between the material and

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57 *Cold Storage* Teaser Trailer, by metaLAB(at)Harvard (2014), on the Harvard Depository in Southborough, Massachusetts, https://www.youtube.com/watch?v=7QuzrF5BYcI, accessed 21 March, 2014

58 As performed by Samir Bhomik (Media Lab Helsinki) in his dissertation at Aalto University School of Arts, Design and Architecture, Finland, 2016 *Deep Time of the Museum / The Materiality of Media Infrastructures*

informational aspects of cultural heritage continues. This requires a grounding of analysis in its precise material and symbolical techno-logical condition: cables, tubes, heating systems, protocols, codes.

The traditional archive, library and museum has concentrated on the material storage medium. Once digitized, such an object becomes "metaphorical" indeed, subject to increasing periodic data "migration", transmission and processing.

For the post-industrial age, communication theory has declared that information is a new kind of epistemic essence, not energy nor matter (Wiener 1948). But high-frequency data processing, though apparently almost immaterial and hidden from obvious visibility, has resulted in more energy consumption and rare earth materialities than ever. Negentropic computing memory, embodied energy costs and the memory of material objects interlace in the maintainance of cultural heritage.

The process of digitizing museum objects is translating them into a different form of existence, from matter and energy to information with a different "temperature" ratio. There is data entropy in using digitization of material heritage by scanning it into computers for further storage, processing and transmission, thereby turning the museum of artefacts into "cloud" collections for the representation and broadcasting of digital memory through networks, media installations and digitally-embedded museum spaces.[59] At the same time, with 3D-printing, a material object re-emerges as the very simulactum of heritage, connecting to the macro-temporal energy cycle of petrol by the very use of its plastic ingredients for printing (as accentuated in the Additivist manifesto).

Behind every act of digitization for cultural heritage and its digital representation lies a chain of material and energetic resources indeed, ranging from silicon chip manufacturing to voltage for high-frequency data processing. The life-span of such non-human media infrastructures shrinks by the increasing speed of disruptive technological innovations; obsolete media technologies return to the earth as residue of digital culture, resulting in growing layers of toxic waste, returning the media "archaeological" metaphor into reality.[60]

["Half times" of knowledge]

The notion of "half time", well known from calculating the decrease of radiation in nuclear waste depositories, exists for the discourse of knowledge as well. There is nowledge measurement in the alphabetic regime as well. Bibliometry calculates the time in which a publication is heavily read, borrowed from

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59 See Samir Bhowmik, Deep Time of the Museum: The Materiality of Media Infrastructures, Doctoral dissertation, Aalto University, Helsinki (Aalto Art Books) 2016, esp. chap. 5.2.3

60 See Jussi Parikka, Media Geology, xxx, 2015

libraries and quoted, resulting in the citation index which once induced the origin of the "PageRank algorithm" for the search engine Google.[61]

Do texts, sounds and images lose their qualification of "cultural heritage" when the key to their code has been lost?

[Some proposals for long-time security and visibility of nuclear deposit sites still count with human recognition in the far future. Among the strategies to symbolically mark nuclear waste depositories such as in Carlsbad, New Mexico, where the radio-active half time is calculated for 10 000 years, one option is a *Gestalt* diagram ("Mister Yuk"), in fact a human face which by geological move of the North pole will change its expression from angry to friendly within such 10 000 years. This "slow motion" communication examplifies the option of "correlation": variant self-similarity of signals over time.[62]]

The functional timelessness of heritage-as-information vs. its material and energetic embodiment

Cultural heritage refers to *media* in two senses: There are genuine technical objects on the one hand, and pre-technological objects transformed ("sampled") into media records for preservation. Its core operation is the sampling-and-hold electronic module which is transsubstantiating "analog" physical world signals into binary ("digital") information.

The notion of cultural "heritage" privileges the receiver perspective; the term "tradition" is rather sender-centered. In terms of communication theory and engineering, the media-epistemic and -archaeological focus is on what happens inbetween, the literate *medium* (channel) interval (both spatially and temporally) and the analog transduction or discrete coding of signals for channel adaption.

[Different from the field of texts or images, a more dramatical dis-continuity has been introduced to cultural heritage by technology in sound and speech which in pre-phonographic times had been inaccessible for technical preservation.]

The tactical (media-archaeological) perspective deals with a precise analysis of the concrete scenarios which are critical within that scheme, such as signal transduction (analog) and coding (the sample-and-hold mechanism as core of A/D conversion), channel noise and storage media decay. Flat temporality here replaces the historicism of long-term preservation and general concepts of "cultural memory": transitive analysis and the microscopic "close reading" of (and by) storage technologies, and its micro-epistemological critical reflection.

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61 See Larry Page / Sergej Brin, xxx

62 See Gregory Benford, Deep Time. How Humanity Communicates Across Millennia, xxx (Avon) 1999

"Mass digitization is far from a straight-forward technical affair."[63] But the focus on media economy as "infrapolitics of the platformization of the web"[64] and their related discursive imaginaries, nevertheless obscures the archival technologics behind, the technical infrastructure and logical interoperativity of such "big data". No analysis of such topics is valid without a close analysis of the precise technical act, at least marginally it has to address the techno-mathematical act of digitization at all, such as Optical Character Recognition (OCR), and the (sometimes erroneous) scanning process, especially Google's "Linear Book Scanner" the standardization processes for Internet communication, in mass digitization assemblages.[65]

The analysis of the "distinct temporality that relates mass digitization to the forces and ideas of industrialization and globalization"[66] needs to be counterbalanced by a close reading of the micro-temporality of its operational infrastructures.[67]

The current mass digitization phenonemon aks for contextualizing it in a media archaeology of monopolizing knowledge sovereignty as achieved by McLuhan's teacher Harold Innis who defined imperial structures by their time- or space-"biased" communication media.[68]

"The Great Transcription has begun.[69] Analog-to-digital conversion of printed text heritage into machine-readable form, different e. g. from the manuscript-to-print transcription in early modernity or book rolls to parchment codex (the material condition of emperor Justinian's legal "code") in late antiquity, does not remain within the alphabetic regime, but is in fact a spatio-temporal transcoding as well: digital sampling depends on software (algorithms) to unfold again.

Analog-to-digital conversion and quantization of the "Gutenberg galaxy" of printed books to computers and mass digitization ("scanning") of existant cultural texts (the transformation of singular books from boundary objects to open sets of data) have resulted in "big data" which still wait for a qualitative turn in their usage. It is no more exclusively human collectives but machines which have become agencies of cultural memory politics.

Converting printed text heritage into less enduring but ephemeral machine-readable form is the drama and pathology of contemporary media culture. Its cultural phantasma is the total archive, but its core scene is the sampling device of the digital scan machine.

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63 Nanna Bonde Thylstrup, The Politics of Mass Digitization, Cambridge, Mass. / London (MIT Press) 2018, 137

64 Thylstrup 2018: 127

65 Thylstrup 2018: 31

66 Thylstrup 2018: 26

67 See xxx Klyne / Axel Volmar (eds.), Hardwired Temporalities, forthcoming

68 See Thylstrup 2018: 45

69 A term coined by Finnish artist-engineer Erkki Kurenniemi in the 1970s, in his text: Computer Eats Art, reprinted and translated in: Joasia Krysa / Jussi Parikka (eds.), Writing and Unwriting (Media) Art History. Erkki Kurenniemi in 2048, Cambridge, Mass. (MIT Press) 2015, 97-105 (100)

Mass digitization has not only resulted in a massive energy and funding consuming infrastructure but will result in uncertain archives. Different from the manuscript-to-print transcription in early modernity or the massive microfilm projects in 20th century libraries, global projects like Google Books or Europeana, or para-legal "shadow libraries" like previous East-European samizdat and current Monoscop or UbuWeb as well, do not remain within the alphabetic code, but in fact are a transcoding as well. It will no longer be more exclusively human collectives but machines which read, even understand cultural knowledge by reading its textual memory by random access, in "deep" machine learning.

"To achieve serendipity, mass digitization projects have often sought to take advantage of the labyrinthine infrastructures of digitization, relying not only on their own virtual bookshelves, but also on the algorithmic highways and back alleys of social media."[70]

Material media entropy

Cultural transmission theory deals with two kinds of entropy. Complementary to the necessities of low storage temperatures (Mo i Rana), the concept of "informational" temperature has been developed. There have been *techniques* of cultural tradition so far; recent *technologies* are no simple escalation but a new epistemic quality in the transmission of cultural heritage.

Photographic negatives and prints, just as magnetic tapes charged with audio, video or binary signals, are subject to physical entropy - different from the informational entropy *within* digital photography.[71] In the Internet culture of *online* retrieval, digitally archived images, safely kept at a distance from immediate human contact, appear uncontaminated by the passage of time. When the analog photographic image is digitally sampled into coded symbols, it is iconic no more but a series of alphanumeric characters (as presented in the control room in the movie *The Matrix* (USA 1999).

Material media memory starts with its basic matter, such as electric condensers and the circuitry of technological configurations. Media-scientific (rather than hermeneutic) analysis of cultural artefacts is operated by non-human agents like measuring devices as active media archaeographs.[72] The preservation of material semantics and aesthetics is an ever-growing problem for analog media art starting from old photographs, which have had a surprising endurance over 150 years, but increasingly turn yellow. Early

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70 Thylstrup 2018: 124

71 See Wolfgang Hagen, Die Entropie der Fotografie. Skizzen zur einer Genealogie der digital-elektronischen Bildaufzeichnung, in: Herta Wolf (ed.), Paradigma Fotografie. Fotokritik am Ende des fotografischen Zeitalters, vol. 1, Frankfurt/M. (Suhrkamp) 2002, 195-235

72 See Josef Riederer / Alheidis von Rohr (ed.), Kunst unter Mikroskop und Sonde. Naturwissenschaftliche Untersuchungen an kulturhistorischen Objekten, Handbuch zur Ausstellung der Staatlichen Museen Preußischer Kulturbesitz (Berlin 1973)

cinematographic nitrate films with their chemical material tend to burn when stored somewhere too hot, or in colour films the colours fade away. So there is physical entropy, the tendency to particular disorder within the material. With the magnetic audio tape, one can listen to a 50 year old magnetic tape and still hear a lot - which is a positive surprise, but at the same time there are increasing dropouts. Here "time" passes, as physical intrusion.

Cooling down media memory: video testimony

While explorer Robert Scott and his men once have been immersed in the snow of the Antarctic, the photographic negative films they produced have survived in cooled-down latency.

In contemporary media culture, in order to preserve digital memory for ages, it is advised to put devices like the USB stick in the refrigerator. Kryonics refers to the inverse Arrhenius equation: the speed of chemical reactions within the very materiality of electronic devices decreases with temperature.

[There is "temperature" even in traumatic media memory. The idea to audio-visually record the testimonies of Holocaust survivors, initiated in 1979 by Dori Laub, took shape as the "Holocaust Survivors Film Project. "Despite the name, filming was conducted from the start in videotape"[73] with the original recording format being three-quarter-inch U-Matic videocassettes. "Due to deterioration of the magnetic tape, the original videocassettes are currently stored in a temperature-controlled room in the Yale archives. The video testimonies currently available for viewing at Yale are all VHS copies of the originals."[74]]

A temperature-controlled room in video archives can only slow down, but not arrest the entropy of the magnetic tape. The vulnerability of material signal carriers to physical entropy is counter-acted neg-entropically by digitization, resulting in an increasing "tension between storage and dissemination at the base of this archive" (ibid.). On the techno-material level, the entropy of *analog* video is slow degradation, wasting away. This is familiar to the human experience of time as passing, the one-directional time arrow. But digital sampling freezes such a video recording in its actual state, suspending it from "history" as further transformation. There is a remarkable difference between analog video signal deterioration and digital pixel artifacts (or glitches in the sonic sphere) - a kind of testimony to time itself.

For signal storage, so-called "archival tapes" (magnetophonic records) in broadcast archives (radio, television) need to be gently heated up to decoalesce in order to play them again for copying, digitizing and migration. Radical media archaeology, being close to techno-mathematics, concentrates on the other side of such entropy.

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73 Amit Pinchevski, in: The Audiovisual Unconsciousness: Media and Trauma in the Video Archive for Holocaust Testimonies, in: Critical Inquiry, vol. 39, no. 1 (Autumn 2012), 142-166 (145)

74 Pinchevski 2012: 145, note 7

The material vulnerability of material signal carriers to physical entropy is "neg-entropically" counter-acted (in Norbert Wiener's sense) by converting it into digital information. All of the sudden, passive storage turns into knowledge in latency. Once being digitized, the electronic image is open to algorithmic search options like similarity-based image retrieval. The traditional architecture of the archive is based on classificating records by external inventories / metadata. Analyzing a digital image from *within* allows for detecting order from apparent disorderin by dynamic analysis, which is an "archive" no more, but algorithmically ruled processuality. After scanning an image, entropy defines "how easy it is to predict the unknown data values given the values we already know. If an image consists of a few monochrome areas, its entropy will be low"[75] The physical laws of thermodynamics habe been transformed into a measure of information in the mathematical calculus of information engineering (Shannon) and therefore returns within computation and data compression itself.

"Tradition" of cultural knowledge in terms of communication engineering

While a phonographic recording captures the temporally unique acoustic signal for time-shiftable identical *reproduction* by replay, the alternative is its techno-mathematical Fourier analysis as transformation of the wave form into its numerical frequencies. Coded transmission not only allows for reproduction (in Walter Benjamin's sense) which is subject to quality loss, but for identical *regeneration*. Discretely coded (not modulated) signals even imply their mapping onto another (future) "alphabet", just like typography (the mechanically printed book), different from the graphic idiosyncracies of the manuscript, invites for identical reproduction already as its very technical *raison d'être* (*arché*). From that derives an immediacy of communication between sender and receiver (author / reader) which short-circuits historical distance in favour of time-less "real presence"[76].

[Different from analog communication media where a non-cultural physical signal (such as high fequency electro-magnetic waves for radio broadcasting) is *modulated* by cultural articulation like speech or sound, digital communication, though still depending on embodiment in physical signals, achieves a mathematical abstraction from noisy material carriers by *coding*. The signal is not simply transduced but informatized, like a sequence of electric impulses can be mapped to the ternary Morse code (which itself is mapped onto the alphabet). Archaeological heritage is signals from the past which requires real numbers to mathematically describe their qualities, while symbolically coded heritage allows for mapping it to integer numbers which makes it (after Leibniz' dyadic system and Boole's symbolic algebra and Shannon's mapping this to switching circuits) accessible to binary computing. Such symbols still require residual embodiment in physical signals, but the variety of such materiality

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75 Lev Manovich, How to Compare One Million Images?, in: Understanding Digital Humanities, hg. v. David M. Berry. Basingstoke: Palgrave Macmillan 2012, 249-278 (266)

76 Ernst Robert Curtius, Europäische Literatur und Lateinisches Mittelalter, Bern 1948, 24

does not affect the invariance of the code - be it mechanic, optic, acoustic, magnetic or electric.[77]]

The media-archaeological dispositive for (almost) lossless reproduction of information by identical symbols has been the Gutenberg printing technology (as opposed to handwritten copies of manuscripts) with its negative types to re-produce letters positively in identical numbers - a form of reproduction later reinvented by the photographic negative, the Talbot Kalotype (different from the unique Daguerre positive). Reproduction technology both disconnected and liberated the reproduced object from its ritual context, by replacing the unique event in space and time (the condition for its "auratic" character) by its expositional value. Cultural "heritage" is thus replaced by "tradition" as mechanisms of transmission, storage and processing.[78]

[The monopoly of telecommunication across space and time, once held by state-owned mailing, archival and telephone systems, according to an argument by Bernhard Siegert, ended with the digitalization, where transmission itself (in its traditional sense) runs out, becoming a mere function of mathematised (rather than materially transmissional) signal processing (realtime, compressing etc.).[79]]

"How, by what channels and by what techniques, were the spiritual *arcana ecclesiae* transferred to the state so as to produce the new secular arcana imperii of absolutism?", historian Ernst H. Kantorowicz once explicitely asked in terms of communication theory.[80]]

There has been a long cultural tradition of techniques to preserve cultural knowledge across generations. The discursive perspective for memory instutions has been strategic, that is: in long, that is: "historic", almost eternal time spans. In times of media culture, this horizon is replaced by short-term intervals, both due to a change in the phenomenology of cultural time and due to increased speed of technological innovations. Not only that heritage agencies have become more technological themselves, but technological solutions for preservation do not allow for long-time strategies any more. They ask for tactical skills. Memory agencies are not primarily about cultural memory as such but about flexible adaption of cultural records to technological changes. Emphatic concepts like heritage are replaced by what in computation is called short-time "buffer" or even "cache" memory.

Towards a mathematical theory of cultural memory communication

77 "Alle diese Signale können im Prinzip zur Darstellung ein und desselben Signalcodes eingesetzt werden." Franz Pichler, Codes: Mathematische Objekte zur Übermittlung von Nachrichten, in: Peter Weibel (ed.), Open Codes. Leben in digitalen Welten, brochure to exhibition at Zentrum für Kunst und Medien, Karlsruhe (zkm) 2017, 39-41 (39)

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

79 Siegert 2003: 285

80 Mysteries of State. An Absolutist Concept And Its Late Mediaeval Origins, in: Hardvard Theological Review vol. 47 (1955), 65

[Instead of concepts in historical discourse, options of cultural heritage transmission might be calculated in terms of probabilities, based on the entropy theorem from communication engineering. As opposed to analog wave forms, discrete impulses, against distortions or noise to the signal, can almost ideally be relatively easily detected, filtered and regenerated in the transmission channel[81] after reception (and in reverse coded respective the channel in the moment of transmitting). The *repeater-regenerator* has been a telegraphic device allowing for quasi-invariant signal transmission. Binary information here beats the traditional parameters of "historiographical" tradition. Binary (on-off) PCM allows for maintaining a high quality signal in spite of noise and interference, as long as it is just possible to recognize the presence of each pulse across a spatial or temporal distance. The noise in the transmission channel is replaced by noise on the signifying level, the critical moment of transduction. In PCM systems, the signal-to-noise ratio is set by the quantizing noise of analog-to-digital sampling.[82]

This is the ratio of symbolically coded heritage in terms of communication theory: "Assume the received signal *E* to be a function of the transmitted signal *S* and a second variable, the noise *N*. [...] The noise is considered to be a chance variable just as the message [...]. In general it may be represented by a suitable stochastic process"[83]; probabilities for the preservation of cultural artefacts can thus be calculated in mathematical terms: E = f(S, N), with adding the temporal dimension to the communication channel: E = f(S, N, t).

Right at the beginning of his book on Norbert Wiener, Masani formulated the problem of writing biographies in terms of such a *signal-to-noise ratio*: "The basic proposition of cybernetics that signal = message + noise, and that the message, and not the noise, is the sensible term in communication, is applicable in all sorts of contexts [...]. Wiener is the signal, and for us the Wiener-message, and not the Wiener-noise, must be of significance."[84]]

Instead of a rigid dichotomy, there is rather a delicate transition between immediate signal "transmission" and delay by "storage", as became apparent in magnetic voice recording at the very moment of its technical invention by Oberlin Smith in 1888: "Imagine that speech could be transmitted over a telephone line at a very slow 'rate of travel', so that at a particular point in time the entire message would be somewhere in the wire between speaker and listener"[85] - literally "in the medium" which Shannon's definition of the

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81 Roch 2009: 102

82 See Claude E. Shannon / John R. Pierce / B. M. Oliver, The Philosophy of PCM [*1948], in: N. Sloane / A. Wyner (ed.), Claude Elwood Shannon. Collected Papers, Piscataway (IEEE) 1993, 151-159 (155)

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

84 P. R. Masani, Norbert Wiener 1894-1964, Basel / Boston / Berlin (Birkhäuser) 1990, 19

85 Friedrich Karl Engel, A Hundred Years of Magnetic Sound Recording, in: Journal of the Audio Engineering Society, Vol. 36, No. 3 (March 1986), 170-178 (171)

transmission channel. Acoustic delay lines have been in use for random access memory in early digital computers indeed.

Coding cultural memory: Re-generative instead of material tradition

[Conceived in terms of cultural history, "[t]radition is nothing if not diachronic."[86] Really? The meaning of "cultural heritage" shifts its focus from its previous emphatic macro-temporal ("historical") notion to the analysis of the nonlinear time-based and time-basing micro-mechanisms of transmission. While tradition has been associated with long-time memories across deep historical time so far, this emphatic horizon now shrinks to a mere extension of the present (as its re- and protentive short-term "working memory") - a dramatic shift of the temporal prefix in the age of algorithmic, that is: re-generative (instead of inherited) memory, algorithmic re-production.]

In the age of algorithmically driven data processing, re-generative (instead of inherited) memory takes place, a techno-*poiesis* of tradition (as known from the definition of rhythmicized oral poetry[87], relegating the past to the present not by notational, cinematographic or phonographic signal recording but by logical re-enactment.

[In communication engineering, the binary coded signal has been preferred against the analog wave form which is vulnerable to all kind of noise in transmission - just as alphabetic writing against the continuous voice in oral poetry. Coded pulse trains allow a significantly more secure form of transmitting and storing the signal against unintended noise and mathematically calculated efficiancy.]

[Memory records from media culture consist of two bodies: the material (subject to physical deterioriation / Boltzman entropy) and the logical (almost invariant regarding the "historic" time arrow, Shannon-entropy like informational space). The symbolical notation of time and its physical reality are incommensurable.[88] But even in logical space, since its symbols have to be embodied in some kind of matter (be it paper and ink), there is no zero-entropy. Symbolical codes have to be materialized as analog signals in physical matter like a phonographic groove; thereby they are subject to material corruption "with time", that is: Boltzmann-entropically.]

A sequence of dots and dashes in Morse telegraphy is not simply a symbolic expresssion like articulated speech or alphabetic writing, but the symbolic is embedded in a physical *time* signal, thereby unfolding in a world of its own. During transmission (the Delta-*t* interval of the *medium* channel) the intended message is suspended from any cultural meaning and temporariliy assumes a non-cultural existence.

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86 John Miles Foley, Traditional Oral Epic. The Odyssey, Beowulf, and the Serbo-Croatian Return Song, Berkeley / Los Angeles / Oxford (University of California Press) 1990, 3

87 Foley 1990: 200

88 See Michel de Certeau, Writing vs. Time: History and Anthropology in the works of Lafitau, in: Rethinking History. Time, Myth, and Writing, ed. M.-R. Logan / J. F. Logan, New Haven: Yale French Studies 59 (1980), 37-64

Against physical deteriorization with time, the symbolic code is neg-entropic. In antiquity, Ptolemy´s atlas of the world was meant to be handed down to posterity in what Mario Carpo calls a "digital format". After listing the locations, for each place he indicates the geographic coordinates and then advises not to copy the actual maps but to regenerate it on the basis of the numerical data exclusively. So what is transmitted is not the picture but an alphanumeric code. Once encrypted, the message depends on the knowledge and sharing of software to decipher and recreate the image itself, resulting in an a-historic form of tradition; a re-generative memory. In that way, the alphanumeric code is more enduring than marble, parchment or architecture. "Geometry is still geometry, regardless of the machines that process it - compasses or computers."[89]

Ptolemy's *Geography* developed a model for lossless tradition by means of coding the map (that is: informatisation). Ptolemy beats the risk of errors in manual copying of charts by radical digitization.

Since Homeric times in antiquity, the "technology" of coding language[90] made cultural transmission analphabet-based knowledge.

[In the Renaissance, Leon Battista Alberti in his treatise *De statua* proposed a procedure for the lossless transmission of three-dimensional objects by digitalisation. When a body is subdivided into a network of discrete points; the position in space of each one can be precisely indicated by a system of coordinates, allowing for the material body to be symbolically copied and reproduced, almost invulnerable agains noise in hand-drawn copying. This has since been the ratio discrete channel-coding for transmission of messages - be it at a spatial or temporal distance.]

The fundamental problem of cultural heritage in terms of communication theory is "reproducing at one point either exactly or approximately a message selected at another point."[91] Hereby, technologies of communication transmission (across space) and storage (across time) converge; "delayed transfer" has been the term coined by Jack Goody for symbolically coded archival tradition. A coded message may be deciphered at any moment in later times as long as the reader - be it human or machine - shares the knowledge of the originary alphabet.

Cryptology of "inherited" encoded knowledge

Not only that the present increasingly communicates its cultural heritage by digital text, sound or image files; the past already has been symbolically, even digitally registered as alphabetic code.

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89 Mario Carpo, Building with Geometry, Drawing with Numbers, in: Andrew Goodhouse (ed.), When Is the Digital in Architecture?, Montreal / Berlin (Canadian Center for Architecture / Sternberg Press) 2017, 33-44 (43)
90 Walter Ong, Orality and Literacy. The Technologizing of the Word, London 1982
91 Shannon / Weaver, The Mathematical Theory of Communication (1949), 31

The chance of a successful decoding of textual messages in the far future depends on transmitting its code as well. Ventris deciphered Mycenean "Linear B" writing from ancient Greece on the basis of his training in Second World War time decipherment of coded messages[92] - the very context which generated the mathematical theory of communication (Shannon).

Within such coded messages, proper names are "rigid" denominators in Kripke's sense; they do not change with context. Alan Turing managed to crack, in Bletchley Park's decipherment huts, the German military code (codes by the Enigma machine) by concentrating on proper names in the sequence of encoded letters, just like the decipherment of "Linear B" by Ventris / Chadwick and of the Rosetta Stone by Champillon (the pharao's name, marked by graphic accentuation). When the deciphering becomes time-critical (which is not true for most of cultural semiotics, or paleography), highly technical computing becomes vital as real-time mathematics.]

Umberto Eco's introduction into semiotics, through, clearly separates sign from signal. Semiotics, when understood in terms of communication engineering rather than as cultural studies, is a branch of communication dealing with the study of "the formulation and encoding of messages by sources, the transmission of these messages through channels, the decoding and interpretation of these messages by destinations, and their signification."[93]

"Re-presencing" past architectures from information: The *ahistorical* temporality of virtual reconstructions

Architecture is *lasting* in the material sense of Bergsonean temporal *durée*. When "transmission" in communication is slowed down to storage, time itself becomes its channel.

Every architectural material form, once actually built, is subject to physical entropy - while every articulation of "digital" architecture is entropic in the sense of Shannons information theory. Digital informatization clashes with the material endurance of architecture

The archaeological entropy of past urban spaces is re-versed by informational entropy. In 1896 A. S. Murray visited the ancient site of Ephesos and reports about its state: "The entire area was overgrown with vegetation, and the few visible remains were lying about in such confusion that no definite plan could be distinguished"[94] - kind of disorder which human capacities of pattern recognition can not decipher any more. Only when rearragend as data arrays such traces become readable again by a different kind of architecture - the architexture of computational microchips.

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92 See Michael Ventris / John Chadwick, Documents in Mycenean Greek, Cambridge 1956

93 As defined in Sebeok 1985: 451

94 Quoted after David George Hogarth, Excavations at Ephesos, The archaic Artemisia, London 1908, "Preface"

Computer applications in archaeology apply quantitative, statistical data analysis. Geographic Information Systems (GIS) link data to maps for the survey of excavations, in on-site recording of excavations and post-excavation analysis. The graphic display of both reconstructions and simulations results from the same data set.

There have been proto-"digital" forms of transmitting architectural information for posterity indeed. Alberti developed a method for the lossless tradition of architectural urban memory by radically sampling and quantifying its cartography into numbers in a Cartesian grid.[95]

In an ironic turn, when reenacting an obsolete computer architecture within a present computer by emulation, former hardware itself is transformed from a material object into an alphanumerically coded text.

In reverse, a notorious case of a media-active archaeology of past architecture has been the baroque Frauenkirche cathedral in Dresden, ruined at the end of Second World War and since remaining a memorial. Its reconstruction has notoriously been assisted by IBM, computing its elementary structures, and literally "calculating" its remaning material stones for authentic inclusion into the reconstruction.

There is a tempor(e)ality of digital preservation of architecture from *within* the architecture of computing systems themselves.

What has been called "archaeological reconstruction" by the resposible project leaders has created the impression of time-axis reversal against the essential characteristic of historical time which is material entropy, as notoriously expressed in architectural ruins. In Dresden, the architectonic reconstruction has been a media-archaeological one indeed; computer calculation re-configured the remaining building bricks and stones into the core of the reconstruction.

"[...] computer-simulated rooms have established links, unities, and coherences wherever the factual state [...] consists essentially of lacunae. Now computer simulations may close up these gaps - say, in the famous IBM action of computer-projecting the ruins of the abbey church of Cluny as a virtual reality."[96]

Retro-computed architectonic data produce "a data record that has never existed before. The ruin, beyond its imaginary completion, is also stored in symbols or algorithms. Each stone, whether preserved or simply presumed, has entered an objective structure" - in fact, an archi(ve)structure, "that makes it addressable according to its dimensions and characteristics. Each stone is both a fetchable data record and a fetchable procedure of its playback."[97]

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95 See Mario Carpo, Alberti's Media Lab, in: idem / F. Lemerle (eds.), Perspective. Projections and Design, London (Routledge) 2008, 47-63

96 Friedrich Kittler, Museums on the Digital Frontier, in: Thomas Keenan (ed.), The End(s) of the Museum, Barcelona (Fondació Antoni Tápies) 1996, 67-80 (72 f.)

97 Kittler 1996: 73

Computer simulations of bygone architecture do not merely generate new forms of user interfaces as content; its actual medium message is that they reconstitute architecture as informatized objects, by object-oriented computing.

In reverse, Geoffrey Shaw's media-artistic installation *Legible city*, a version of which still exists at ZKM Karlsruhe, built an urban architecture consisting of letters, thus rendering spatial data accessible for nagivation by visitors on a bicycle in a virtual cave.[98] But if a virtual space is "rooted" in the real world at all, it is in the materiality of the computing device itself; Shaw's 3D-spaces actually reflect the graphic power of his SGI workstations which now are themselves subject to emulation in order to maintain the installation. Since in the meantime, Scott's *Legible City* installation at ZKM Karlsruhe is not "legible" any more; its reenactment has become a problem of the software archive, taken care of by the Center of Digital Tradition (Codigt) at KIT Karlsruhe.

"Emulation". The challenge of operative software heritage

With classical archaeology (classics) and *Kulturwissenschaft*, media archaeology shares the interest for material culture. What differentiates technological objects from archaeologically excavated cultural artefacts is their technical as well as logical being and - contrary to a museal assembly - capacity of acting (under electric voltage) by themselves. This essence can not be articulated by immobile exhibition or frozen storage only[99] but requires re-enactment. Re-enactment is "a transhistorical *operative practice*"[100] which correlates with Heidegger's reading of ancient Greek *techné*: "a 'revealing' that not only 'brings forth' but also *makes present*"[101]. The material and logical conditions under which stored signals from the past can be "re-presenced" are central to media archaeology indeed.

Within electronic computing, the traditionally separated categories of durable materiality *versus* immaterial reproducible code converge. In order to conncect to the physical world, there is the necessity of material implementation of all logical systems to become dramatically active. Just like mental processes depend on their implementation in bio-cybernetical hardware (neuronal synapses)[102], techno-symbolical analysis (*Schaltalgebra*) itself can operate only when being implemented into swichting circuits (such as electro-magnetic relays).[103] There is a crucial difference between the mathematical paper model of the Turing-Machine of 1936 and the really implemented machinery called

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98 Lev Manovich, Die Ästhetik des navigierbbaren Raums, in: Katalog vision.ruhr: Kunst Medien Interaktion auf der Zeche Zollern II/IV Dortmund, Ostfildern (Hatje Cantz) 2000, 84-90 (87)

99 See Steven Lubar / W. David Kingery (eds.), History from Things. Essays on Material Culture, Washington / London (Smithsonian Institution Press) 1993

100 Sobchack 2011: 324

101 324

102 See Geoffrey Jefferson, The Mind of Mechanical Man, in: British Medical Journal, June 25, 1949, 1106-1110

103 See Claude Shannon's master thesis: A symbolic analysis of switching relays (1938)

"computer" today which brings speed as a time-critical parameter into the algorithmic event.

Digital culture itself has generated a new epistemic practice for its own heritage: the concept of emulation. Different from a soft concept of emulation which only cares for the recreation of the phenomena and appearance of the machine-to-human interaction, emulation in its radical sense actually re-enacts the function of an obsolte computer (and its temporal behaviour in the strong sense of simulation) *within* a contemporary one. It ontologically actually *is* in the state of the previous one (resulting from the concept of the Universal Turingmachine which is able to emulate any other machines once coded). As challenge remains migrating and emulating to future systems the emulator software itself.[104]

When a present computer emulates a previous computer game designed, e. g., for a Commodore 64, it is in both a historical and a trans-historical state. It *is* (according to the definition of the Universal Turing Machine) in the C64 configuration, while at the same time, in the background the contemporary operating system is running. The timing of the present system speeds the emulation up, so that the characteristic C64 time behaviour as once coded in BASIC language has artificially to be simulated. With the temporal dimension, functional emulation (the matahistorical realm of techno-mathematical logic) becomes "high fidelity" in terms of micro-temporal behaviour. Today's "retro computing" resembles what is known as *reverse engineering*. It liberates the primary artefact, the C64 computer, from its overwhelming historisation and musealisation, and rather identifies the time-tunneling immediacy of its operational being.

The departments for computing in national heritage agencies nowadays face the challenge of the preservation of software as museum object.[105] Software represents a new kind of cultural artefact indeed. Essentially, it is not a material object any more, rather an executable file which unfolds only when being processed (a truly processual time-object). While the computer as hardware can be traditionally displayed as an immobile museum object, its time- and "bit-critical" processes (including unintended electro-physical bit-flipping) can never be displayed in a frozen state.

When techno-archivally "proteced mode" knowledge of both hard- and software is replaced by "open access", this will result in a more probable ensurance for tradition of media culture. Software repositories like GitHub keep the sources of digital culture transparent. May this kernel of contemporary cultural heritage be migrated into the future.[106]

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104 See Jens-Martin Loebel, Lost in Translation. Leistungsfähigkeit, Einsatz und Grenzen bei der Langzeitbewahrung digitaler multimedialer Objekte am Beispiel von Computerspielen, Glückstadt (VWH Verlag Werner Hülsbusch) 2014

105 Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing Vol. 4 No 3 (1992), 206-210

106 See Friedrich Kittler, Museums at the Digital Frontier, in: Thomas Keenan (ed.), Limits of the Museum, Barcelona (Fondacion Tapies) 199x, xxx

When the concept of emulation, in its media archaeological sense, encompasses the re-enactment of hardware as well, this becomes critical, e. g. for soundchips in early home computers like the legendary SID 6581 soundchip for the Commodore 64 which has been a hybrid of analog synthesizer components and digital circuitry for addressing them. Alternative to simply recording sound samples as future "historic quotes" of a SID soundchip, an emulator aims at re-creating its sonic effects which is critical since the hear detects the delicate difference between a simulated and an authentic analog sound.[107]

Referring to Kenneth Thibodeau's criteria, every digital artefact is a trinity of physical, logical and conceptual object.[108] "[T]here is a spectrum of options for digital preservation ranging from an accent on preserving the technolgy [...] to preserving the things produced with the technology [...]" - while admitting that "for things, such as computer games, that are essentially embodiments of the technology should fall closer to the technology end of the spectrum"[109], by maintaining hard- and / or software in operation by emulation. Thibodeau's preferred priority, data format conversion, "abondons the original hardware and software" - disrespecting technology itself as authentic cultural record - "and overcomes obsolescence by reformatting data files to newer formats that can be retrieved and used with current software"[110]. "As technologies change over time, the persistent object form can remain stable. The only thing that needs to be changed is the translator. [...] In a persistent archives <sic>" - different from Foucault's neographism of *l'archive* - "the collections are not materialized as such", aiming "at independence of technological infrastructure."[111] Thibodeau's perspective is the archivist which explicitely privileges maintaining the legal integrity and *documentary* authenticity of the record provenance form against the priority in the maintenance of its original technological infrastructure. Media archaeology rather considers the *monumental* essence of such technologies a value worth of preservation as cultural heritage in itself - since all technology, different from merely phyiscal natural objects, is an accumulation and condensation of "hard-wired" cultural knowledge itself. In the case of technically generated records, their familiar "historical context" is not social any more, but becomes autonomous as its technological context: electronic circuitry in terms of hardware, operating systems in terms of software.

Different from previous cultural techniques of maintaining cultural heritage, the epoque of computational media has generated a "digitally born" concept of emulation unknown in previous cultural epistemology. Media theory both enhances and delimits its range. The logical object (including the operating system of an obsolete computer) may be preserved well by emulating such

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107 See Claus Pias, Medienphilologie und ihre Grenzen, in: Friedrich Balke / Rupert Gaderer (eds.), Medienphilologie. Konturen eines Paradimas, Göttingen (Wallstein) 2017, 364-385 (378 f.)

108 Kenneth Thibodeau, Overview of Technological Approaches to Digital Preservation and Challenges in Coming Years; http://www.clir/pubs/reports/pub107/thibodeau.html (accessed May 2017)

109 Kenneth Thibodeau, Digital Preservation Techniques: Evaluating the Options, in: Archivi e Computer, Bd. 11, Heft 2 (2001), 101-109 (104)

110 Thobodeau 2001: 105

111 Thibodeau 2001: 109

software incapsulated in another software, but the early Cathode Ray Tube monitor for archaic computer game display had a different material semantics than the LED screen with its pixelised matrix. The temptations of "cloud computing", metaphorically dissimulating the hardware of any computing *a prior*, already results in strategies where even hardware apparently disappears into the cloud: "To save bygone software, files, and more, researchers are working to emulate decades-old technology in the cloud", Jessica Leigh Hester reports[112], quoting Seth Anderson, the Yale University library's software preservation manager: "You're removing the physical element of it."

The answer to preserving hardware beyond its material existence is its physical modelling, just like Digital Signal Processing can emulate the physical world by virtual (informational) means. But this requires, beyond the "textual" archive of source codes, and beyond photographic or video recording, a symbolic notation of such hardware as well, such as circuit diagrams. By sampling analog signals to digital data, and by physical modelling, digital media culture not only replaces former cultural techniques by the *techno-logics* of computational heritage, but has generated the tools for overcoming its own limitations - at least in principle, *en arché*. The digital age thereby has a concept for its own "heritage" already: *futurum exactum*.

HALF-LIVES OF KNOWLEDGE. A Media-Archaeological Point of View

In the discussion of how long knowledge can be expected to last, and in what form, the human factor is not longer exclusively determinative. Regarding the challenges and chances of maintaining knowledge across emphatic temporal distance, and in respect to the options of reconstructing lost or damaged knowledge, an "archaeological" perspective (in its various meanings ranging from the academic discipline up to Foucault's *Archéologie de Savoir* and even media-archaeology) is useful which focuses on the non-human agencies of knowledge traditions. Media theory here is helpful since it addresses both the philosophical (epistemological) and the engineering (techno-mathematical) questions involved. The present focus is on nuclear energy both as medium and as subject of knowledge reflection, with a special accent on the delicate relation between technology and time.

For the analysis of the techno-logics of knowledge tradition, a focus on both the material (technical) forms which are subject to physical entropy and on the immaterial (logical), almost time-invariant codes of transmission is required: the physical *versus* the symbolical mode, material embodiment ("markers") *versus* logical implementations (archives). In this context "symbolic" does not refer to symbolism in its iconological sense of metaphorical meaning (such as the much discussed "markers" on nuclear waste sites[113]), but to discrete characters in coding information (ranging hitherto from alphabetic letters and

112 In her article "The Quest for a Universal Translator for Old, Obsolete Computer Files" from March 8, 2018, website ATLAS OBSCURA, https://www.atlasobscura.com/articles/how-to-open-old-computer-files, accessed March 14, 2018

113 See the OECD Radioactive Waste Management publication *More than Just Concrete Realities: The Symbolic Dimension of Radioactive Waste Mangement* (2010)

Arabic numbers up to the binary code of Zeros and Ones embodied as Low and High voltage levels in electronic computing). The current shift from material memory as cultural premise to techno-mathematics as the dominant form of cultural communication corresponds with a different kind of tempor(e)ality: cultural memory, once intended for eternity, transforms into an on-going practice, economy and aesthetics of short-term intermediary storage: repeated data migration, "the enduring ephemeral"[114].

In every act of cultural transmission, there is a symbolical (code) level on the one hand which is tentatively time-invariant, and an entropical, temporally decaying physical reality on the other, as expressed in the allegory of history painted by Anton Raphael Mengs on the ceiling of the room which links the Vatican museum (material objects) to the Vatican library (the regime of symbolic writing).

Cultural analysis in the media-archaeological way

The material forms of cultural tradition are subject to physical entropy, while the almost immaterial alphabets of transmission endure almost time-invariant as long as the code is preserved. The physical mode differs from the symbolical code, material embodiment ("markers") from logical implementations (archives). The shift from archaeological materialities as cultural premise to techno-mathematics as the new form of enculturation corresponds with a different kind of tempor(e)ality: Cultural memory, once approximately intended for eternity, transforms into short-term intermediary storage and repeated data migration.

"Writing vs. Time": Lossless tradition in the symbolic code?

In every act of cultural transmission, there is a symbolical (code) level on the one hand which is time-invariant, and an entropical, temporally decaying (“historical“) physical reality on the other. An illustration for tradition is Anton Raphael Mengs' *Allegory of History*, painted by on the ceiling of the room which links the Vatican museum (material heritage) to the Vatican library (the regime of symbolic signs).

There is another 18th century allegory of the mechanisms of cultural transmission, the frontispiece of Lafitau‘s publication *Moeurs des sauvages Ameriquains* (1724). This image confronts archaeologically silent, but enduring material artefacts with the discursive, but transient murmur of historiography. The viewer is confronted with the encounter of writing and time in a closed space littered with artefactual traces coming from both Classical Antiquity and the New World. "One holds the pen, the other the scythe, [...] which approach each other without ever touching, asymptotically. History deals with relics which can be seen, and seeks to supply explanations; ancient *things* which

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114 See Wendy Chun, The Enduring Ephemeral, or The Future Is a Memory, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 184-203

have become mute throught the degradation owing to time may to some extent become clearer [...].[115]

Michel de Certeau enhanced this allegory by drawing the configuration of Chronos and Clio abstracted to a diagram where the supposed prologued lines of the curved scythe and the linear pen become vectors. Diagrams do not depend on iconological representation while at the same time asking to be enacted by reasoning.

Directly deciphered in terms of mathematics, the pen-line (as x-axis) becomes the asymptote of the scythe as hyperbel (on the y-axis). There is no point where the function touches or traverses the x axis itself: no convergence between material and symbolic phenomena of time.

In Lafitau‘s front cover illustration, the allegorical figure of Chronos is endowed with a weapon (the scythe) indicating devastation with time - in fact „noise“ which happens in the temporal channel of transmission (to rephrase it in terms known from transmission engineering). Such material loss of information is compensated by the female allegory of Clio „writing“ history: copying of symbolic letters is an almost lossless technology of tradition.

Tradition here means the separation of signal from noise by means of symbolic transcription. When we have ("received") a message which has somehow become scrambled with another, unwanted message (which we call noise), the challenge lies in "unscrambling these and restoring the original message with as little alteration as possible, except perhaps for a lag in time"[116] - which is the problem of filtering.

[Correlation allows for a memory induced by the signals themselves; therefore Nuclear Magnetic Resonance, for example, is non-metaphorically at work in the concept of a ten thousands of years radio memory.[117]]

Towards the non-human observer: The media-archaeological point of view

Media archaeology is a method of enquiring into cultural time which is not limited to the historical (narrative) approach, that is: taking not exlusively of the human point of view on culture, but the perspective of technologies as well which themselves become active "archaeologists" of knowledge. Technological media machines produce articulations that do not necessarily need a human observer or translator any more in order to communicate between themselves.

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115 Annette Lavers (rev.), on: Michel de Certeau, Writing versus Time, in: Rethinking History. Time, Myth, and Writing, ed. M.-R. Logan / J. F. Logan, New Haven: Yale French Studies 59 (1980), in: History and Theory XXII, 3 / 1985, 330f

116 Norbert Wiener, Time, Communication, and the Nervous System, in: Annals of the New York Academy of Sciences, Bd. 50, 1948/50, 197-219 (205)

117 On spectral correlation diagrams for time frequency detection (TFR) in signal analysis, see Boualem Boashash (ed.), Time Frequency Signal Analysis and Processing. A Comprehensive Reference, Amsterdam et al. (Elsevier) 2003, 505

Symbolic decoding (alphabetic "reading" and linguistic "undertanding" of the semantics of these strings of charactes) of an ancient Codex (e. g. the law code of emperor Theodosius) is not enough to grasp its historical significance, the historian R. G. Collingwood writes in *The Idea of History* (1946, 283). One must rather know and "re-encact" (not just analyze) Theodosius' contextual "situation".

On the other side, human "reading" becomes more and more machine-dependent. A groove on a vinyl record might still be "read" by a skill human interpreter (at least roughly), just like a slide of a micro-film compresses a text. Electronic recording (be it acoustic or optic signals, or textual symbols) requires refinded technology to be accessible for humans at all. Media archaeology is more akin to the gaze of the optical scanner that to that of the anthropological observer. Communication addressed to the future needs to take into account such non-human readers.

The aim of long-time depositories of nuclear waste is that the final disposal does not depend on human presence and intervention in order to fulfil its safety goal. Is this nessecary anti-hermeneutic, or does it lead to a re-freshed hermeneutics?

According to Hans-Georg Gadamer[118], the temporal gap which separates two cultural times makes it impossible for the latter to re-access the former unless they are linked by a common horizon of tradition ("wirkungsgeschichtlicher Zusammenhang"), e. g. a continuum of cultural sense from Homer to Heidegger. The "humanistic" paradigm relies on the hermeneutics of symbolically coded communication between distant spaces and across temporal distances. But beyond such understanding, Karl Popper declared a "third world" of knowledge which exists even in the absence of humans. The subjectivist point of view takes a book without reader for a meaningless object: "But logarithmic tables can be generated by a computer and be printed. These numbers may probably never be read by humans on earth. But each of these numbres contains what Popper calls "objective knowledge"[119].

Temporal invariance: the "humanistic" co-originality

Karl Popper reminds of a world of knowledge without a knowing (human) subject, reminding of Plato's notion of *anamnesis*. "Even though this [...] world is a human product, there are many theories in themselves and arguments in themselves [...] which have never been produced or understood and may never be produced or understood by men."[120] Popper imagines two apocalyptic scenarios: All machines and tools will be destroyed, as well as all human knowledge about such devices; only libraries survive and the human capacity to learn from them (depending on the reading / decoding / alphabetic capacity / literacy); thus the cultural world can be re-activated.

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118 Hans-Georg Gadamer, Wahrheit und Methode, Tübingen 1972

119 Popper 1972 / 1984: Karl R. Popper, Objektive Erkenntnis. Ein evolutionärer Entwurf, 4. Aufl. Hamburg (Hoffmann & Campe) 1984, 118 f.

120 Popper 1979: 116

In an alternative thought experiment, even all libraries are detroyed: "there will be no re-emergence of our civilization for many milennia"[121]. There has been a scenario which actually happened: the destruction of the ancient library of Alexandria (which included, next to book rolls, a machine park and academic laboratory as well). Since knowledge was already embedded in machines, geometries und letters around the ancient world, the physical loss was a damage, but surprisingly not an epistemic loss, not desctructive to technical and cultural knowledge), since most of such mathematics and machines has been re-invented independently since several times.

"One of the main reasons for the mistaken subjective approach to knowledge is the feeling that a book is nothing without a reader: only if it is understood does it reallys become a book; otherwise it is just paper with black spots on it."[122] But "[...] a book, or even a library, need not even have been written by anybody: a series of books of logarithms, for example, may be produced and printed by a computer" (ibid.). Popper insistes on the "possibility or potentiality" of such prointed characters in a book of being understood, "and this potentiality of disposition may exist without ever being actualized or realized"[123].

"We may imagine that after the human race has perished, some books or libraries may be found by some civilized successors of ours (no matter whether these are terrestrial animals, which have become civilized, or some visitors from outer space). These books may be deciphered. They may be those logarithm tables never read before [...]. [...] it is sufficient that it might be deciphered [...] in order to belong to the third world of objective knowledge" (ibid.).

"Knowledge in this objective sense is totally independent of anybody's claim to know."[124] Even if the knowledge of so-called Pythagoras' early Greek physical experiments with the vibrating string (the monochord) or his mathematical reasoning with drawings of geometrical bodies ("Der Satz des Pythagoras") had been completely oblitterated by loss or destruction in the process of tradition, the rules would inevitable be re-invented. There is a co-presence which takes place in the physical respectively mathematical world, different from the contextual and discursive relativity of cultural (historical) human activity.

Across the temporal gap: The negentropic effort

Most transmission of knowledge within the temporal domain, understood here in reverse to space-bridging communication channels, takes place in materially embodied and symbolically encoded forms. In this context "symbolic" does not refer to symbolism in its iconological sense of metaphorical meaning (such as

121 Karl R. Popper, Objective Knowledge. An Evolutionary Approach, Oxford, 2nd. ed. (Clarendon Press) 1979, 108

122 Popper 1979: 115

123 Popper 1979: 116

124 Popper 1979: 109

the much discussed "markers" on nuclear waste sites[125]), but to discrete characters in coding information (ranging hitherto from alphabetic letters and Arabic numbers up to the binary code of Zeros and Ones embodied as Low and High voltage levels in electronic computing).

The very notion of "record" might be questioned in media-archaeological terms. The RKM *Glossary of Key Terms* defines a record as "an object or a selected piece of data / piece of information that has been committed to a medium". "Medium" is the term assigned by Claude Shannon's communication engineering to the channel of transmission. Let us understand communication here not in its vulgar sense as meaningful exchange but more formally as a sequence of signals and/or symbols. More specifically, information theory requires that something unknown is transmitted. In techno-mathematical terms, information theory which deals with temporal (in-)variances is close to correlation analysis. In order to compare a signal (*s*) at a (much) later *punctum temporis* with itself (*s'*), a correlator is required, which is based on means to store and to delay the signal.[126]

Thus regeneration and relays are required. Different from traditional transmission as endurance where the massages was confined to one materiality (such as inscriptions in stone, or letters in the postal system), in dynamically encoded symbolic transmission the embodiment of information as signal may be variously *transduced*, i. e. change from one form of energy into another.

Information transmission (different from previous body- or paper-bound material messengers) is almost independent from its material signal (as defined in Norbert Wiener's *Cybernetics*).

In order "to counter the passage from negentropy to ultimate entropy", Thomas Sebeok proposed a "relay system" of information transmission, creating intervals by sampling: "to divide the 10,000-year epoch envisaged into manageable segments of shorter and, resumably, reasonably foreseeable periods"[127] which he counts by generations of humankind which would update the message periodically like relays in an electric communication channel.

Cultural knowledge is context-dependend (the so-called "historical" variable); that is why the RKM *Glossary of Key Terms* demands for a record that it is "kept together with the appropriate context and structure for later use"; whereas physical and mathematical laws claim invariance against temporal change in terms of ergodic behaviour.

The term *ergodic* defines "a stochastic process in which every sizable subsequence is the same statistically, and every state will occur in the long

125 See the OECD Radioactive Waste Management publication *More than Just Concrete Realities: The Symbolic Dimension of Radioactive Waste Mangement* (2010)

126 See F. H. Lange, Correlation Techniques, London (Iliffe Books) / Princeton, New Jersey (van Nostrand Company) 1967

127 Sebeok 1985: 464

run"[128]. Ergodic theory had its origins in the work of Boltzmann in statistical mechanics problems where time- and space-distribution averages are equal.

"Culture is not based on direct replication"; by teaching and imitation. The transmission of culture is temporally extended."[129] The model of "tradition" as transfer in the time-based channel relies on the long-term persistance of records - be it "direct" or "indirect transmission", passing knowledge from one generation to another, known from "oral" cultures, or as data "migration" in digital preservation of records. This differs from a rather a-historical model of co-originality (German *Gleichursprünglichkeit*). Agriculture, e. g., was invented independently many times.[130]

The notion of "migration" itself points to a shift of emphasis which is essentially connected to the challenge of nuclear waste deposits. For long time already, the occidental fixation on "end"archives (eternal storage) has been replaced by the notion of intermediary, temporary, even ephemeral storage, the "Zwischenlager", leading to intermediary storage in permanence, thus: dis-locating the storage elements ("migrating" them in due intervals).

Static continuous permanence (Bergsonean time) is being replaced by a dynamic concept of repeated actualisation: endurance by refreshing which is not only a principle in contemporary electronics (the electronic image in television and video; memory administration in computers) and communication technologies ("sampling"); this corresponds with the practice of archiving the Internet as well, as performed by the wayback-machine of the Internet Archive

To what degree is the endurance of knowledge dependent on material resistance to entropy? Direct transmission without intermediary agencies relies on the material endurance of records. In order to keep it meaningful (since "much cultural information is semantic knowledge"[131]), the medium itself here has to be made the message (McLuhan), independent of its original semantic content.

From a cult(e)urocentic perspective, a book without human reader might be a meaningless object: "But logarithmic tables can be generated by a computer and be printed. These numbers may probably never be read by humans on earth."[132] Jede dieser Zahlen verkörpert das, was Popper als "objektives Wissen" identifiziert. Jene "dritte" Wissenswelt, die nicht des menschlichen Subjekts zum Begriff bedarf, erinnert damit in der Tat an das Modell der anamnesis in Platons Dialog Menon. "Even though this [...] world is a human product, there are many theories in themselves and arguments in themselves [...] which have never been produced or understood and may never be produced or understood by men."[133]

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128 Glossary of "Neural" Terms, in: Kohonen 1995, 253-281 (261)

129 Robert Boyd / Peter J. Richerson, The Origin and Evolution of Cultures, New York u. a. (Oxford UP) 2005, 378

130 Boyd / Richerson 2005: 355

131 Boyd / Richerson 2005: 423

132 Popper 1979: 115

133 Karl R. Popper, Objective Knowledge. An Evolutionary Approach [1972], Oxford, 2nd. ed. (Clarendon Press) 1979,

"The architecture of the church may help store information about the rituals performed within. Without writing, however, the ability of artifacts to store culture is quite limited. [...] many artifacts are very difficult to reverse-engineer."[134]

Unless as oral literature, "[t]he vast store of information that exists in every culture cannot simply float in the air. It must be encoded in some material object" (ibid.). But what if information is not encoded ("written") in material storage media, but performed as modulation of dynamic signals, like speech or music in electro-magnetic radio transmission? Charles Babbage, the inventor of a mechanical proto-computer in Victorian London, once declared: "The air itself is one vast library, on whose pages are forever written all that man has ever said or woman whispered."[135]

Physical differes from logical permanence of documented information - between the (media-)archaeological monument and the historical document. "The European (Nordic) concept of preservation apparently relies on archival means and methods. To ensure a long term preservation of knoledge the U.S. researchers on the other hand focus on the use of markes or 'monuments' on the sites of the nucelare waste repositories."[136]

"Knowledge" in the RKM *Glossary of Key Terms* is defined as "the ability to understand and utilize the available data, information and records". The reader here obviously is meant to be human, but what if future readers are rather "robot historians" as suggested by Manuel DeLanda?[137]

The task of long-term preservation of technological artefacts aims at communication with a future audience, but this intelligence might not be necessarily "human" any more. A message need not be the result of a conscious human effort for the transmission of an idea; "the record of the thickness of a roll of paper kept by a condenser working an automatic stop on a [...] machine is also a message [...]."[138]

Karl Popper extended this concept to a "third world of knowledge" as an inherent, physically or mathematically implicit form of knowledge in latency (waiting to be recovered or to be self-revealing (much beyond Polanyi's rather sociological notion of "tacit" knowledge). The alternative model to knowledge tradition thus is co-originality ("Gleichursprünglichkeit"), that is: the emergence of a same (or similar) knowledge anew at any given time, independent of its culturally transmitted knowledge (as indicated by the monumental formulaic "$m = E/c^2$" inscription at the COVRA nuclear site, The Netherlands which will faint parallel to the nuclear half-time, but implicitely remain intact as natural law).

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134 Boyd / Richerson 2005: 423

135 The Works of Charles Babbage, hg. v. Martin Campbell-Kelly, Bd. 9: The Ninth Bridgewater Treatise. A Fragment, 2. Aufl. 1838, London (Pickering) 1989, Kapitel IX, 36

136 Fryksén 1996: 326

137 Manuel DeLanda, War in the Age of Intelligent Machines, xxx 1991

138 Norbert Wiener, xxx 1942, 3 f.

Charles Sanders Peirce describes diagrammatic reasoning as such: "Similar experiments performed upon any diagram constructed to the same precept would have the same result."[139] In terms of tradition of sensitive knowledge, this results in a concept of knowledge re-enactment rather than passive reading.

Mathematical knowledge here replaces semiotic decipherment. Semiotics as a branch of communication deals with the study of "the formulation and endoding of messages by sources, the transmission of these messages through channels, the decoding and interpretation of these messages by destinations, and their signification"[140]. In order to decipher messages sent within the world of techno-mathematical knowledge itself, it requires something like DeLanda's "robot historian" indeed.

Nuclear time: radio-active memory

The essence of information is neither matter nor energy; in the RKM *Glossary of Key Terms* it is defined as "organized data that may or may not be recorded on a medium". Still it is dependent of signal embodiment either as matter (invasive "inscription", "record") or as energey (electro-magnetic waves as carrier for modulating radio signals).

Radio-active memory represents a special case which demands for more radical, daring theories and "radio"-based operations of knowledge transmission which is not limited to human understanding excluisvely any more.

Nucelar waste differs from previsously known material artefacts which are meant to be preserved for cultural memory by tradition in that it is matter which actively remains dangerous. This corresponds with a need for active (if not to say radio-active) memory.

In the case of radio-active deposits, we are not dealing with immobile materiality or passive symbolic codes, but with matter which is emits signals actively. Nucelar waste, by definition, is "radio" active; so why not take the radiation itself as basis for continuous signalling? "Every form of physical energy propagation can be used as a channel for conveing messages."[141]

Sonification might be an option of indicating the degree of radio-active decay itself - and not just "acoustically" coded images as in the case of the Voyager disc or acoustic records from noises, sound and ethno-music recorded on earth.

In the case of the copper discs attached to both Voyager space satellites (launched in August and September 1977) which was intended to carry messages from the earth to extra-terrestrial intelligence, the gold-protected aluminium record cover itself has been not only inscribed with diagrams to

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139 Charles Sanders Peirce, Collected Papers, Bd. II: Elements of Logic, Cambridge, Mass. (Harvard UP) 1932, 350

140 As defined in Sebeok 1985: 451

141 Sebeok 1985: 459

visually communicate information about human civilization but contained (and still contains, on its voyage in outer space) some ultra-clean Uranium 238 with a radio acticity of about 0,00026 microcurie. Its steady decomposition into its "daughter isotopes" turns it into a kind of radio-active clock, with a half live of about 4,51 billion years. An extra-terrestrial intelligence, by measuring the remnants of this sample might calculate and infer the time which has passed since that sample of Uranium had been fixed to the record cover.[142]

This kind of communication rests on natural, not cultural (arbitrarily coded) laws, on physical invariances - just like the mathematical formulas engraved and encoded onto the disc cover attached to the two Voyager satellites in 1977, just like the Search for Extraterrestrial Intelligence (the SETI project) involves the networked scanning of radio-astronimical noise to detect improbable messages inbetween, a future intelligence will detect such a regular noise pattern.

Present research detects far-distant echoes of the universal Big Bang - which in fact is tracing re-verberations. Let us take "radio" in its original, media-archaeological sense, thus turning its meaning into a tool for knowledge transmission. Radiation is a form of communication which transmits itself (creating its own "media" channel, the electro-magnetic waves).

The nuclear time clock (Ernst Jünger)

In his book on the ancient art of time-keeping by sand - the hour glass - (a critique of the wheel-driven mechanical clock), Ernst Jünger reminds of tempor(e)alities which transcend the reach of mechanical clocks. Mechanical time keeping, on the long term, endures and is reconstructable, different from electronic clocking devices.

Geological chronometry counts ultra-long temporal periods from layers of geological formations. A similar physics-based chronometry is based on the radiation caused by physical decay. The notion of "half time" in radio-active matter refers to the temporal interval in which the activity of a given radionucleid is reduced to its half; that is: half of the atomic kernels have been transformed - while emitting ioniciszing rays - into another nucleid. This temporal interval may range from micro-seconds to trillions of years; according to this range, the measuring tools and methods vary. "Die Erde wird als Uhr betrachtet, von der man die Weltzeit abliest"[143]. Jünger notifies the dialectic re-turn of such "elementary time" in clocks driven by atomic oscillations (quartz, atoms, electrons) - which means measuring time from within the physical world, rooted within its measures and rhythms instead of simply being symbolic, that is: arbitrary cultural enactments.

Depositories of radioactive waste embody a kind of "hot" nuclear clock indeed; the half-time values of radiation decay of uranium itself may serve as a long-

142 Carl Sagan et al., Signale der Erde. Unser Planet stellt sich vor, München / Zürich (Droemer & Knaur) 1980, 41

143 Ernst Jünger, Das Sanduhrbuch, Frankfurt / M. (Vittorio Klosermann) 1954, 200

time counter which - communicated *as* and *by* radio waves - is the message of the nuclear medium.