TEMPERATURES OF CULTURAL TRADITION: TECHNICAL "COLD" STORAGE, "TIMELESS" CODES

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Tradition: Transmission across space / storage over time

While cultural articulation distributed over space may be exhausted after signal transmission, when intended to be communicated into the future (with the channel of transmission becoming "suspended" or "frozen" into endurance, that is: storage time), the signals requires material embodiment. Both modes, "transmission" and "storage", can be formulated as extreme formulations of one and the same theory cultural communication engineering.

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.[1] While tele-communication across spatial distance takes place in the more or less synchronous temporal mode (real-time), while knowledge communication is remarkably asynchronous (postponed, "delayed transfer" in terms of Jack Goody) - the "postal letter" paradigm of humanistic knowledge exchange.

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1 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

Cultural "heritage" is a metaphor borrowed from genetics. Jurij Lotman, though, defined cultural exactly 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 symbols (be it alphabetic, be it the alphanumeric code).

Agencies of cultural transmission across time

The nineteenth century project of a German national museum of cultural history (Germanisches Nationalmuseum) at Nuremberg, in its juncture of memory based on archives, on the collection of objects and on its library, prefigured some criteria of technologies of tradition in its proper sense which is collecting - storing - editing. The enterprise undertaken by the Freiherr von Aufsess, a repertory of sources on German medieval history, drastically separated (archaeological) monuments and (historical) information, creating a data bank on national history until the year 1600 and thereby creating somewhat Vannevar Bush in 1945 termed a *memory extender*. Thus the GNM aks for a re-reading in terms of media theory, discourse analysis and the science of documentation: the (re)construction of the past as a function of its reco(r)dings. Biblio-museal-archival memory is at the same time an effect and the deconstruction of (literally) „collective“ cultural techniques.

Conventional institutionalized "techniques" of cultural tradition (archives, libraries, museums) have escalated (or even disrupted) into autonomous machines, therefore: technologies of cultural heritage.

The mechanisation of the library as container of alphabet-based knowledge resulted in literal "cold storage" (different from "hot" historiographical imagination), 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*:

[Video]

a) Heritage in terms of Boltzmann entropy

The return of energy within information storage: case museum

In terms of media ecology, there is actual energy costs of cultural memory institutions such as archives for unique records and libraries for textually coded knowledge on the one hand, and museum for materialities of culture.[2] At that point, the Norwegean National Library comes in, with its two bodies of memory: the Oslo location for conventional books and Mo i Rana for technological heritage - logical *versus* physical preservation.

In the city of Berlin, the triadic constellation of knowledge heritage (library -

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2 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*

museum - archive) is combined in the administration of the Stiftung Preußischer Kulturbesitz, including a laboratory for restauration and preservation of textual and material record. This allows for a comparative study of technologies of cultural tradition with a focus on the cultural heritage *versus* ecological impact, with a focus on the "anthropocenic" issues of hardware consumption, 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) turns technological; the infrastructure of memory itself becomes an ecological issue in both McLuhan's and environmental studies sense.

The focus on the material and energetic factors in museum heritage itself corresponds with the media-archaeological focus on hardware, protocols and and techno-logical infrastructures.

In the museum, the endurance of physical artifacts is incommensurable with its digital museology (in data centers) in terms of temperature, humidity, energy use and embodied energy. Once more, physical and/or informational "entropy" clash. Technicians at Mo i Rana take care of media memory in the Boltzmann-entropy sense, while the National Library in Oslo takes care of the informational memory in the Shannon-sense. Within computational culture (Google or "virtual" stock market server farms, this divide continues. This requires a grounding of analysis in its precise material and symbolical techno-logical condition: cables, tubes, heating systems, protocols, codes.[3]

[Material and energetic conditions for signal and data storage]

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

For the in post-industrial age, communication theory had 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.

Here, heating and cooling system are inverted by the process of digitizing the museum objects, that is: translating them into a different form of existence, from matter and energy to information with a different "temperature" ratio. There is data entropy in using 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.[4] At the same time, with 3D-printing, a

3 See Alexander Galloway, Protocol, xxx

4 See Samir Bhowmik, “Deep Time of the Museum: The Materiality of Media Infrastructures.” Doctoral dissertation, Aalto University, Helsinki (Aalto Art

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).

The move from traditional to digital museum results in an expanded media infrastructure that is energy-intensive and resource-dependent (argument Bhowmik 2016); behind every act of digitization and 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.[5] Digital cultural heritage is achieved for the price the environmental burden.

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

Cultural heritage refers to *media* in two senses: genuine media-borne 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 as micro media theatre of transsubstiating "analog" physical world signals into binary ("digital") information.

The notion of "heritage" privileges the receiver perspective; "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): the analog transduction or discrete coding of signals for channel adaption

A most dramatical dis-continuity has been introduced to cultural heritage by technology not in the field of texts or images, but sound and speech which in pre-phonographic times had been inaccessible for technical preservation.

The strategical (media-theoretical) perspective is a general theory of cultural tradition engineering (concentrating on the interlacing of the storage and the transmission function of communication media as "delayed transfer", as termed by Jack Goody),

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 historicism: transitive analysis and the microscopic "close reading" of heritage technologies.

Books) 2016, esp. chap. 5.2.3
5 See Jussi Parikka, Media Geology, xxx, 2015

Analog-to-digital conversion is the "great transcription" (Rossaak) which, different e. g. from the manuscript-to-print transcription in early modernity or book rolls to parchment codex in late antiquity, does not remain within the alphabetic code, but is in fact a spatio-temporal transcoding as well: digital sampling which depends on software (algorithms) to unfold again.

It is no more human collectives but machines which have become agencies of cultural heritage.

Cultural transmission theory deals with two kinds of entropy Against the necessities of 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.

Material media entropy

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 in digital photography[6] Material media memory starts with its basic matter, such as electric condensers and the circuitry of technological configurations. Art history studies know the heuristics of "material iconography" (Monika Wagner). Scientific (rather than hermeneutic) analysis of cultural artefacts is media-active archaeology, operated by non-human agents like measuring devices as active media archaeographs.[7] The preservation of material semantics and aesthetics[8] 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 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. Only here "time" passes as physical intrusion.

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6 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

7 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)

8 See W. E., Zeit, die an Medienmaterie haftet. Erkenntnismöglichkeiten technoarchäologischer Hardware, in: Irene Schubiger (ed.), Schweizer Videokunst der 1970er und 1980er Jahre. Eine Rekonstruktion, Zürich (Ringier Verlag) 2009, 188-194

Cooling down media memory: video testimony

While explorer Robert Scott and his men once have been immersed in the snow of the Antarctic, the phonographic 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. Quantum computing (with its elementary qbits) requires extreme cooling to mainain its fragile coherence.

There is "temperature" even in traumatic media memory. After the idea to audio-visually record the testimonies of Holocaust survivors was initiated in 1979 by Dori Laub, it took shape as the "Holocaust Survivors Film Project. "Despite the name, filming was conducted from the start in videotape"[9] 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."[10]

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 - "[...] a development that reasserts the tension between storage and dissemination at the base of this archive."[11] On the techno-material, media-archaeological level, the entropy of *analog* video testimonies still shares the sense of history: 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 deterioration and digital pixel artifacts (or glitches in the sonic sphere) - a different 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

Instead of focusing on the ecological costs of cultural heritage technologies, radical media archaeology, being close to techno-mathematics, concentrates on the other side of such entropy.

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9 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)

10 Pinchevski 2012: 145, note 7

11 See Amit Pinchevski, The Audiovisual Unconscious. Media and Trauma in the Video Archive for Holocaust Testimonies, in: Critical Inquiry, vol. 39, no. 1 (Autumn 2012), 142-166 (145, note 7)

The material vulnerability of material signal carriers to physical entropy is being counter-acted ("neg-entropically", 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 in fluctuation, that is: dynamic, 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"[12] 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.

b) Heritage in terms of Shannon entropy

"Tradition" of cultural knowledge in terms of communication engineering

While phonographic recording captures the temporally unique acoustic signal for time-shiftable identical *reproduction*, the alternative is its techno-mathematical Fourier analysis as transformation of the wave form into its numerical frequencies. Coded transmission (Alberti's concept) allows for identital *regeneration*.

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 (as different from the unique Daguerre positive), which led Walter Benjamin to remark that reproduction technology both disconnected and liberated the reproduced object from its ritual contect, by replacing the unique event in space and time (the condition for its "auratic" character) by its expositional value. Tradition is thus replaced by mechanisms of transmission, storage and processing.[13]

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

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

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

of mathematised (rather than materially transmissional) signal processing (realtime, compressing etc.).[14]

"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 asked.[15] 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 any as such but about flexible adaption of cultural records to technological changes. Emphatic concepts like heritage are replaced by what in computation is called "buffer" or even "cache" memory.

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 libraries and quoted, resulting in the citation index which once induced the origin of the "PageRank algorithm" for the search engine Google.[16]

Only non-human-addressed texts, sounds and images, can be still retrieved when the defining cultural semantic or iconologic context has already 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 of the options 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 (auto-)"correlation": invariant self-similarity of signals over time.[17]

The changes of a successful decoding of textual messages in the far future deepends 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[18] - the very context which generated the mathematical theory of communication (Shannon) as well.

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14 Siegert 2003: 285

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

16 See Larry Page / Sergej Brin, xxx

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

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

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 decifferment 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-critial (which is not true for cultural semiotics, paleography or nuclear deposits), highly technical computing becomes vital as real-time mathematics.

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 endoding of messages by sources, the transmission of these messages through channels, the decoding an dinterpretaionof these messges by destinations, and their signification"[19]; Umberto Eco's introduction into semiotics clearly separates sign from signal.

The mathematical theory of communication has been criticized from within the humanities for not being concerned with the "semantics" of the transmitted signals; that is why "noise" here is not just a distortion but as well a possible source of information (just like in secret coding).

Towards a mathematical theory of archival memory communication

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[20] after reception (and in reverse coded respective the channel in the moment of transmitting) by application of the *repeater-regenerator*, a 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.[21]

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

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19 As defined in Sebeok 1985: 451
20 Roch 2009: 102
21 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)

a suitable stochastic process"[22]; 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, Norbert Wiener's biographer Masani formulated the problem of 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."[23]

Instead of a rigid dichotomy, there is rather a delicate transition between immediate signal "transmission" and delay by "storage", as becomes 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"[24] - literally "in the medium" (Shannon's definition of the transmission channel). Acoustic delay lines have been in use for random access memory in early digital computers.

Coding cultural memory: Re-generative instead of material tradition

Conceived in terms of cultural history, "[t]radition is nothing if not diachronic."[25] Really? The meaning of "tradition" 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: generative (instead of inherited) memory. Algorithmic re-production is the post-scriptum to Walter Benjamin's interpretation of post-traditional perception of works of art - a kind of oral (in the sense of: dynamic, variable) memory returns.

In the age of algorithmic, that is: generative (instead of inherited) memory, a kind of secondary "orality" returns. "The individual *poiesis* of tradition" as known from the definition of rhythmicized oral poetry[26] re-emerges as the art of *live coding* today.

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

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

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

25 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

26 Foley 1990: 200

[Oral epic poetry (as has been performed by *guslari* until today in Serbia and Montenegro) communicates knowledge of the past not in the mode of historical discourse, but as a reverberative memory, relegating the past to the present not by notational or signal recording (like presence-generating media such as the phonographic record) but by variable iteration: invariance in dynamic transformation. Local, cultural and political heritage indeed actually emerges *during* the production and emergence of the songs: regeneration rather than simple recall. Absence is transformed into presence, death into life, by the logocentric technology of voice instead of the muteness of printed texts[27].]

The transmission of uncoded cultural heritage has been liberated from its embodiment in material objects by their written or even printed description; tradition thus transformed into coded transmission not for communication across space but across distance to posterity.

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. But 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."[28]

In antiquity, Ptolemy's *Geography* developed a model for lossless, negentropic tradition by means of coding the image (that is: informatisation). Ptolemy faced the risk of errors in manual copying of charts by radical digitization.

For textual transmission since Homeric times in antiquity, the alphabet as a "technology" of coding language[29] made cultural transmission of word-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.[30] This invulnerability agains noise in hand-drawn copying is the

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27 Tanja Zimmermann, The folk instrument *gusle* and its resistance to electrification, published in: xxx, referring to the interpretation by Leopold von Ranke, Die serbische Revolution. Aus serbischen Papieren und Mitteilungen, Hamburg 1829, first chapter ("Lage der Dinge vor den Bewegungen. Nationale Sinnesweise und Poesie"), 35 f.

28 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)

29 Walter Ong, Orality and Literacy. The Technologizing of the Word, London 1982

ratio of Shannon's mathematical theory of channel-coding for transmission of messages - be it at a spatial or temporal distance.

"The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point."[31]

Technologies of communication transmission (across space) and storage (across time) converge; "delayed transfer" is a term once coined by Jack Goody for symbolically coded archival tradition. A coded message may be deciphered at any moment in later times (as long as the reader shares the knowledge of the originary alphabet).

Oscillating between signal and symbol: Reading ancient inscriptions (case *Lapis Satricanus*)

In communication engineering, the binary coded signal has been developed against the analog wave form - just as alphabetic writing against the continuous voice in oral poetry - since it allows to 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.[32] 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.

Bernhard Siegert, in his definition of "Kulturtechnik"[33], refers to the representation of corrupt letters in the ancient Roman inscription *Monumentum Ancyranum* in Andreas Schott's edition (Antwerpen 1579), where *lacunae* are expressed by subsequent dots (110 f.). But a sequence of dots and dashes in Morse telegraphy is not simply a symbolic event, but the symbolic is embedded

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30 On Alberti´s method of digital sampling, especially his *Carta urbis Romae* for lossless "digital" transmission of map of Rome to posterity, see Mario Carpo, "Descriptio urbis Romae". Ekphrasis geografica e cultura visuale all´alba della rivoluzione tipografica, in: Albertiana, Florenz (Olschki) 1, 1 (1998), 111-132

31 Shannon / Weaver, The Mathematical Theory of Communication (1949), 31. Siehe auch Bernhard Vief, Die Inflation der Igel. Versuch über die Medien, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (Hg.), McLuhan neu lesen. Kritische Analysen zu Medien und Kultur im 21. Jahrhundert, Berlin (transcript) 2008, 213-232

32 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

33 Bernhard Siegert, entry "Kulturtechnik", in: Harun Maye / Leander Scholz (eds.), Einführung in die Kulturwissenschaft, Paderborn 2011, 95-118

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 the symbolic and temporariliy assumes a non-cultural existence.

Not only that the present now communicates with a digitized, "sampled" past; the past already has been symbolically, even digitally registered: as alphabetic recordings and historiographic narratives for communicating with the immediate future.

A scene where symbolical writing (history, people, authority) and materiality (archaeology, objects, authenticity) meet is on / in ancient inscriptions, such as the *Lapis Satricanus* from late 6th or early 5th century B. C., discovered 1977 by the archaeologists of the Dutch Institute of Rome during their re-excavation of the temple of Mater Matuta in Le Ferriere (Latio), the ancient Satricum:

http://www.telemaco.unibo.it/rombo/iscriz/satricum.htm

The textual (not environmental) inscription, like flat files of data strings in computing today, does not itself separate words; therefore any transcription is already an interpretation. The epigraphical reading presents the text like this:

[.....]EISTETERAIPOPLIOSIOVALESIOSIO
SUODALESMAMARTEI

This early Latin inscription of just two lines which looks like a votive inscription in itself already deficient, with something missing at the beginning: there is no *arché-logos*. This initial lack which remains to be supplemented keeps the discussion of hypotheses going on. A revision of the ealiest photographic documentation of the stone *in situ* by D. J. Waarsenburg in 1994 - a kind of secondary dig in the archives of archaeology itself - revealed that the literally "i"nitial lacuna can, at least partly, be completed by the letter "I", while another apparent fragment of a letter on the photography, blown up media-archaeologically by computer analysis, turned out to be a blade of grass = Versnel 1997: 180; what is the message, or what is missing: truncated first letter/s or noise (a scratch in the stone)?

A photograph of the primary situation of this inscription when just being excavated *in situ* today is the only recording of its state before the cleaning of the stone from earth and its removal into an epigraphic museum.

The completion of the first word(s) would require either a reverse lexicographic statistical processing of letter sequences, or an analysis of Markov chains as proposed in the mathematical theory of communication (Shannon and Weaver 1963); our certainty depends on statistical probability.

As expressed by Claude Shannon in his essay on prediction and entropy: "The errors, as would be expected, occur most frequently at the beginning of words and syllables where the line of thought has more possibility of branching out."[34]

34 C. E. Shannon, Prediction and Entropy of Printed English, in: The Bell System Technical Journal, Bd. 30, Heft 1 (Jan. 1951), 50-64 (54f)

Only a proper name (*poplios* = Publius?) makes it secure to discriminate a verbal entity; names turn out to be the ultimate rigid denominator (Saul Kripke). The problem of reading the inscription is with how to group and de/compose the letter series in front of this name: the analysis of *ieisteterai* and the problematic integration of the 4-6 letters missing already at the left corner of the inscription, turning this epigraphical case into an allegory of readability of the past (which is by definition absent and deficient). Only a statistical *ars combinatoria* (somewhat at the origins of computing) can offer different readings by sequencing these letter-data:

A) [4-6]*ie iste terai*
B) [4-6]*iei stet erai*
C) [4-6]*iei steterai*
D) [4-6]*ieis tet erai*
E) [4-6]*ieis teterai*
F) [4-6]*ieist et erai* [35]

Image processing routines may be applied to enhance shallow inscriptions and thereby support their deciphering; in calculated enlargment of this close-up by digital filtering (in PhotoShop), digital media themselves act as active "archaeologists" of this past; techno-mathematical signal correlation of (missing-to-existing) letters.

The media archaeological focus on the decisive technological scenarios of tradition is rather microscopical than in terms of historical macro-contexts; in its time lense, temporal distance is compressed to immediacy in the symbolic regime.

The metaphor of the micro- or telescope turns the analysis of heritage into a laboratory practice which itself depends on technologies of detection[36] - just like Walter Benjamin defined the "optical unconscious" which is revealed only by the photographic lense.

Mutilated cuneiform inscriptions from ancient Mesopotamia, e. g., may be restored by holographic signal processing, identifyng visual "spikes" in correlation analysis:

[project] "Intensitäten der Korrelatiossignale bei Verwendung verschiedener angepaßter holographischer Filter", in: Günther Wernicke, Holographische Zeichenerkennung an Keilschrifttafeln, in: Humboldt-Spektrum 4/1995, 22-27, Fig. 5

The challenge of operative software heritage

35 C. De Simone, L'aspetto linguistico, in: C. M. Stibbe, G. Colonna, C. de Simone and H. S. Versnel, with an introduction by M. Pallottino, Lapis Satricanus. Archaeological, Epigraphical, Linguistic & Historical Aspects of the New Inscription from Satricum, 's-Gravenhage 1980, 71

36 See Georges Canguilhem, Wissenschaftsgeschichte und Epistemologie, Frankfurt/M. (Suhrkamp) 1979, 25

With classical archaeology (classics) and *Kulturwissenschaften*, media archaeology shares the interest for material culture. What differentiates technological objects from archaeologically excavated cultural artefacts is their being (technically as well as logically) coupled and - contrary to a museal assembly - capacity of acting - under currency - by themselves. This escalation can not be articulated by immobile exhibition or frozen storage only[37] but requires re-enactment.

With electronic computing, the traditionally separated categories of durable materiality *versus* immaterial time-based performance collapses, in a way analogous to the essential tempor(e)ality of sonic articulation. Once the single tone has been discovered as the basic element of manipulation in composition of electronic music, it could be trated as "material" with its micro-historicity itself. What has traditionally been the ordering of sound in macro-time ("music"), turned out as mirco-temporal essence itself - the tone as a frequency event. "Die Trennung 'akustischer Vorordnungen' *im* Material und 'musikalischer Ordnungen' *mit* diesem Material müßte dann aufgehoben werden."[38] Likewise, around 1900 Henri Bergson elaborated his philosophy upon the phasical insight into the essentially oscillating nature of "material" elements (electrons, atoms); as such, materiality itself is in micro-motion already.[39]

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)[40], techno-symbolical analysis (*Schaltalgebra*) itself can operate only when being implemented into swichting circuits (such as electro-magnetic relays).[41] There is a crucial difference between the mathematical paper model of the Turing-Machine of 1936 and the really implemented machinery called "computer" today which brings speed as a time-critical parameter into the algorithmic event.

The department for *Computing and Control* at the National Museum of Science and Industry in London nowadays faces the challenge of the preservation of software as museum object.[42] 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 are never in *stasis*, just like periodic wave-based acoustics (sonic evidence) aks for

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

38 Karlheinz Stockhausen, Die Einheit der musikalischen Zeit, in: Dieter Schnebel (ed.), Karlheinz Stockhausen. Texte zur elektronischen und instrumentalen Musik, Bd. 1, Köln (DuMont) 1963, 211-221 (214)

39 See Maurizio Lazzarato, Videophilosophie, Berlin (b-books) 2002

40 See xxx Jefferson, xxx (Lister Oration), in: xxx, 1949

41 See Claude Shannon's master thesis: A symbolic analysis of switching relays, in: xxx

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

"musical" performance in order to take place at all - different from visual evidence which persists as an enduring spatial exhibition.

When secret knowledge is replaced by "open access", this might even result in a more probable ensurance for tradition. Software repositories like GitHub keep the sources of digital culture transparent. May this kernel of contemporary cultural heritage be migrated into the future.[43]

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