[Wolfgang Ernst: SCRIPTS ON TECHNICAL MEDIA]

Text Block "RADICAL LOGO-TECHNICAL ANALYSIS: MEDIA ARCHAEOLOGY"

[unpublished so far, roughly edited]

Thematic blocks:

Media Archaeology as Method
Media Archeaology in Practice

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Media Archaeology as Method:

TECHNICAL MEDIA ARCHAEOLOGY (IN A DECLARATIVE SENSE)

Introduction: Historical Media Archaeology vs. the Cold Technological Gaze

So-called "media archaeology" embraces a variety of approaches to technical materialities which deserve to be remembered (in the cultural historical sense), or the be revealed (in the techno-logical sense).[1] Its main divide is between the rather historical, or cultural, *versus* the technocentric approach.

As a method of media analysis, media archaeology addresses the infrastructural level of media practice which Foucault named *l'archive*:

[1] See Erkki Huhtamo / Jussi Parikka (eds.), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011

the governing laws of media, such as Internet protocols[2], or the von Neumann-architecture of digital computers). A more *technical* media archaeology is an aesthetics as well: the "cold gaze" of distanced understanding, but "close reading", of technical circuits, and logical source code. Next it is an "archivology", that is: deeply obliged to archival evidence and historical as well as technological precision (circuit diagrams as source of evidence).

Parallel to such academic models, media archaeology is exercized as practice-based artistic research as well (Garnet Hertz, Paul deMarinis, Morten Riis et al.). Media archaeology which extends to an art form is certainly not a nostalgia for the analogue but reveals the technical basics of media as opposed to the intangible opaqueness of microchip-based media today (whose techno-logicity, against the common user interface-oriented perception, is reduced to the max).

Media archaeology aims at alternatives models of thinking the being of media in (emphatic) time, for an alternative to linear historiography of technology. Apart from rather linear narratives of media origins in the historic sense, which surprisingly persist as a cultural form, there are other levels of media tempor(e)alities: governing principles, archaic essentials - such as the *enduring* infrastructure of the apparently dying mass medium radio, as radio wave-based infrastucture of mobile media communication. And in the symbolical order, the recursive return of the "alphabet" in the digital age with its alphanumerical data processing all of the sudden recalls a genealogy of mathematics which had not been central to media studies in times of analog radio and television.

A more "radical" media archaeology, in its techno-mathematical understanding (a pun with the mathematical square root, the *radix*), is a form of disclosing technically implicit knowledge, which grants media operations themselves an active epistemogenic agency. It has been, e. g., digital signal processing which restored damaged, or disclosed previously inaccessible early phonographic records back to sound, speech and music.[3] Media archaeology is the gesture of "open source" and de-constructing hardware: not simply in the sense of public usage of source codes of computer programs, but in the sense of unclothing media from their designed enframing. By-passing all other aspects of cultural, political, economical, even ethical discourse which ex- or implicitly shape technical media, radical media archaeology traces their essential techno*lógos*, that is: the intertwining of the symbolical order (the code) with actual matter (the electro-technical implementation).

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[2] Alexander Galloway, Protocol. How Control Exists after Decentralization, Cambridge, Mass. / London (MIT) 2004

[3] See Patrick Feaster, Pictures of Sound. One thousand years of educed audio: 980-1980, Atlante, GA (Dust-to-Digital) 2012

The media-archaeological approach stays close to the materiality of media. It is hereby akin to Classical Archaeology which deals with the material remains of a culture (as opposed to philological hermeneutics). But equally it refers to the mathematical (square) "root" (*arché*) in techno-*logos*. There is a risk to be seduced by the archaeological metaphor. Media archaeology is n o t about beginnings, about origins in the temporal sense, but rather about the *arché*, the laws governing media in action. These principles are rather structural than temporal; it only happens at its emergence a medium reveals its structures before it becomes dissimulated by interfaces - like early radio sets.

"The cold gaze" is a description of media-archaeological *aisthesis* indeed, somewhat close to Ernst Jünger's photographic media aesthetics. "One can tell that the object photographed was seen by an insensitive and invulnerable eye."[4] Admittedly, German pre-war engineering culture still lurks through, and the Heideggerian ways of fundamental rethinking of "technics".[5] Today, one would add to the "the cold gaze" the unpassionate ears which listen to the implicitely "sonic", that is: wave- and rhythm-based temporal event emerging from, and within, technomathematical media.[6]

Media science (rather than "studies") asks for a specific mixture of technological competence and epistemological reflection (if not desire). One should indeed expect for a researcher and critic of media to know exactly what is, e. g., the physics of electromagnetic induction, the mathematical equation of Fourier Analysis for time-varying signals (sonic or visual), or the TCP / IP protocol and the topological concept of "routing" in Internet communication engineering. But of course academics do *not* read German media theories primarily to gain technical knowledge, rather to rethink technology in the Heideggeran sense.[7]

There is a certain techno-logocentric, that is: machine- and code-centered school of media studies indeed.[8] The field of (new) media theory seems split between two very different approaches: "Media archaeologists, like Kittler, Wolfgang Ernst or Alexander Galloway describe the non-discursive practices of the techno-cultural archive.

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[4] Ernst Jünger, Photography and the second consciousness, excerpt from: idem, On Pain, in: Photography in the Modern Era: European Documents and Critical Writings, 1913 / 1940, ed. C. Philips, New York (Aperture) 1989, 207-210 (208)

[5] Martin Heidegger, The question concerning technology and other essays, New York, NY (Garland) 1977

[6] See Shintaro Miyazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, in: Computational Culture, Issue 2 / 2012, http://computationalculture.net

[7] An argument in Geert Lovink, Der Verbleib der deutschen Medientheorie, in: idem, Zero comments. Elemente einer kritischen Internetkultur, Bielefeld (transcript) 2008, 129-145

[8] As expressed in Wendy Hui Kyong Chun, Introduction. Did Someone Say New Media?, in: New Media, Old Media. A History and Theory Reader, eds. Wendy Hui Kyong Chun / Thomas Keenan, New York / London (Routledge) 2006, 1-10 (4)

Media phenomenologists like Katherine Hayles, Tara McPherson or Mark B. N. Hansen analyze how phenomena in various media appear to the human cognitive apparatus, that is, to the mind and senses."[9] What is clear by this arbitrary name list already, is that the theoretical front is not one between continental European media archaeologists and media archivists on the one side and Anglo-speaking cultural critics of media practices on the other. The archaeological / archivological approach is rooted in Foucault's definition that *l'archive* "governs the appearance of statements as unique events", whereas archaeology "questions the already-said at the level of its existence [...] and the general archive system to which it belongs"s[10]; it is as well connected with Marshall McLuhan's non-contentist media analysis. Whereas Hansen in his discussion of what is an "image" in the age of new (that is, electronic and digital) media, in an explicit Bergsonean tradition, still insists on the coming-into-being of the mediated image in the "enframing" acts of the human bodily cognition only[11], his more recent research points out that the target of current micro-media and data-tracking "Apps" no longer target human perception but the affective unconscious (or Freud's "Vorbewußtes") in the micro-temporal field (Massumi). In the field of "posthuman cultural studies"[12], radical media archaeology takes the point of view of the machine itself. The "radical" is here interpreted in manifold ways: going back to the roots (which is the archive), to the beginnings (less in the sense of historical causality but temporal originality: the opening and generation of the time-critical *momentum* and of temporal horizons), and finally in the techno-mathematical sense of the square root symbol (for the *radix* of numbers): the basic conditions of media matter (hardware) and algorithms (software).

A media archaeological uncertainty challenge arises here. One can get either get close to the micro-event on the hardware level, but misses the "image". Or one can focus on the algorithm which organises "big" data into a figurative image, but misses its material grounding. Scaling from one extreme to the other unfolds the horizon of media archaeological investigation.

This signal-based approach is different from the rather semiotic approach of Cultural Studies. Apart from some idiosyncasies in graphical notation, there is no principal translation barrier for logical circuit diagrams so far; the world of techno-mathematical engineering cross-culturally wires artefacts into standard operations. For both "forensic" and "formal" materialist analysis[13,] the circuit design of a radio set is not a "text" any

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[9] Kjetil Jakobsen, in chapter 6 of his text "Anarchival Society", discusses "Archaeology versus phenomenology", in: Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010, 127-154 (141)

[10] Michel Foucault, The Archaeology of Knowledge, New York (Tavistock) 1972, 129 and 131

[11] Mark B. N. Hansen, New Philosophy of New Media, Cambridge, Mass. (MIT Press) 2004, 13

[12] Geoffrey Winthrop-Young, Cultural Studies and German Media Theory, in: Gary Hall / Clare Birchall (eds), New Cultural Studies, Edinburgh (Edinburgh University Press) 2006, 88-104 (100)

[13] Kirschenbaum 2008: 10 f.

more but an operative diagram when set in media function. To what degree can textual and hermeneutic metaphors which have been familiar to humanities be applied to electro-material culture? In the years around 1980 late Friedrich Kittler had engineered a modular sound synthesizer which nowadays endures as strange artefacts in the midst of his collected papers. Therefore research artist Jan-Peter E. R. Sonntag has directed an "anatomy" of this three-dimensional circuitry architecture, to answer the question if there is something like an idiosyncratic style or even authorship in Kittler's handling of actual electronics.[14] This is applied media philology, hardware-oriented media hermeneutics in the tradition of what the archaeologist Eduard Gerhard in 19th century once called *monumental philology*. Micro-technological research on signal transduction is not strictly opposed to the media-phenomenological approach; the ways media affect human perception (in best McLuhanite tradition of analysis) is as close to neuroscience as it is to media archaeology.

Case Studies

With no overall consensus about its definition, methods, tools, or even its field[15], there are different ways of practicing media archaeology. Many of them are "re-mediating" new media (theories) with previous ones recursively.[16] At the same time a Foucault-driven media archaeology accentuates the discontinuities which have arisen in media cultures. The German "school" that has emerged in technology-prone media archaeology (ranging from Friedrich Kittler over Sybille Krämer to Bernhard Siegert and Bernhard Dotzler) not only emphasizes material factors as prime movers of media history, but the symbol-driven machine as well. From writing surfaces, and inscriptions on phonograph cylinders or celluloid film to machine architectures and computer code, media archaeologists trace the widening gap between the technological evolution and traditional cultural engineering.

An example for media archaeological reasoning is the approach it takes to "understand" a central artefact in occidental cultural engineering, the wheel-driven clock. Its decisive mechanisms, the anchor or verge escapement with an attached pendulum, in fact turns out to be a formative mechanism to develop the chronotechnical sense of

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[14] See Sebastian Döring / Jan-Peter Sonntag, *apparatus operandi: anatomie*. Der Synthesizer des Friedrich A. Kittler, in: TUMULT. Schriften zur Verkehrswissenschaft, no. 40 (thematif issue "Friedrich Kittler. Technik oder Kunst?", edited by Walter Seitter / Michaela Ott), Wetzlar (Büchse der Pandora) 2012, 35-56

[15] See Erkki Huhtamo's and Jussi Parikka's introductory chapter, An Archaeology of Media Archaeology, in: Huthamo / Parikka (eds.) 2011

[16] See Jay David Bolter / Richard Grusin, Remediation. Understanding New Media, Cambridge, Mass. / London 1999; I. Gitelman, Always Already New. Media, History, and the Data of Culture, Cambridge, MA (The MIT Press) 2006

oscillations which later became basic for the temporal agency of technical media. Media archaeology analyses the mechanisms of time-keeping, and thereby is less concerned with the traces of ancient religious practices embedded in the history of time-keeping technologies but its continuous effect in the present. What is paramount to consider is the *dis*-continuity between the history of religious time-keeping and the evolution of time-based media. Media archaeological analysis, different from the "cultural study" of religion and technology, does not to bring them closer together, but rethink the terms on which they must remain separate: the oscillating clock and its progressive detachment from its original locus in the monasteries of medieval Europe.[17]

Another case is optical media. Their genealogy can not be reduced, by (hi)story telling, to the people who created them, exhibited them, consumed them, and fantasized about them. Its real co-agency have been the machines, with its techno-logical laws of optics and mechanics being its *archive*. Media archaeology does not simply tell "a very different story", but no story at all.[18] "Inventors do not figure as the primary agents, but their creations seem controlled by some external machinic logic rather than by human desires and needs. "So-called humans" rarely appear in Kittler's techno-mathematical media research - even if they return, in the name of desire, in his late works *Eros*, and *Aphrodite*. Media archaeology does not presuppose an primordial binding of media to the social and cultural spaces they occupy.[19] The relegation between cultural and media epistemology acknowledges both the nonhuman agencies (in the sense of Bruno Latour's Actor-Network Theory) and their discursive dependencies.[20]

The Recurrence of Techno-Logical Configurations within Culture

Erkki Huhtamo's combination of *tópos* theory with media archaeology[21] is inspired by Ernst Robert Curtius' studies of literary tradition in Europe[22] where *tópoi* figure as formulas that traverse culture in persistent forms. What seems like unprecedented icons of media culture, such as human-

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[17] See Jeremy Stolow (ed.), Deus in Machina: Religion, Technology, and the Things in Between, New York (Fordham University Press) 2013

[18] John Durham Peters, Introduction: Friedrich Kittler's Light Shows, in: Friedrich Kittler, Optical Media: Berlin Lectures 1999, trans. Anthony Enns, Cambridge (Polity Press) 2010, 5

[19] For a dicourse-orientated approach to past media, see Carolyn Marvin, When Old Technologies Were New: Thinking About Electric Communication in the Late Nineteenth Century (New York and Oxford: Oxford University Press, 1988)

[20] See Cornelius Borck, Electricity as a medium of psychic life. Electrotechnical adventures into psychodiagnosis in Weimar Germany, in: Science in Context vol. 14 (2001), 565-590

[21] See Erkki Huhtamo, Dismantling the Fairy Engine: Media Archaeology as Topos Study, in: idem / Jussi Parikka (eds.), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 27-47

[22] Ernst Robert Curtius, Europäische Literatur und lateinisches Mittelalter, Bern / Munich 1948

machine hybrids ("cyborgs"), may in fact be such visual, or conceptual, recurrent *tópoi* in disguise. Such a genealogy reminds Aby Warburg's *Mnemosyne Atlas* project which identifies the "Pathos formula" traversing occidental art history from antiquity to modern times on a comparative black & white photographies basis, or Vilém Flusser's concept of recurrent "gestures" in media culture. Such a cultural archaeology, or genealogy, of visual media representations becomes a *media* archaeology once not visual symbols of machines, but symbolic machine configurations (in Lacan's, Kittler's and Krämer's sense[23]) themselves are identified as techno-logical *tópoi* (or "memes"). Different from the contextualizing approach of historical media archaeology (Huhtamo 2016: 71), radical media archaeology identifies a *technológos* as an almost autonomous force acting rather by techno-logical (that is: material, and coded) self-reference, and with a temporal logic of its own (*eigen*time) unfolding in culture according to rhythms which differ from historical time. In the Renaissance, Nicola Vicentino proposed an "Archiorgano" organ which provides for 31 tone grades per Octave, in accordance with his 1555 treatise *L'antica musica ridotta alla moderna prattica*. Literary knowledge from ancient Greek music theory here returns as a materialized *tópos*. As a theoretical machine in the sense of the Turing machine (Turing 1937), Vicentino's design is an amazing, mechanically almost impossible, media-archaeological predecessor of contemporary algorithmic realizations of microtonality in computational music. A research project, in 2016, has actually (re-)built Vicentino's diagram, as media-active archaeology.[24]

In early 18th century Sweden, Christopher Polhem conceived a "mechanical alphabet", including (in analogy to the alphabetic vowels) core dynamic mechanisms (lever, wheel, wedge, screw) for his Laboratorium Mechanicum. Just like the concept of memetics in its material sense[25], an inherent technical logic turns out as the central agency here, which acts, to a high degree, rather independent from particular contexts in cultural discourse. Finally, the temporal figure of recurrent *tópoi* has become a technical term for a core operation in algorithmic data processing, to describe iterative software action which recalls itself: "recursion" (a *terminus technicus* recently used by Kittler to explain the recall of the ancient Greek alphabet which was used for linguistic, mathematical, and musical notation equally, by contemporary computing: the alpha-numeric code[26]).

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[23] Sybille Krämer, Symbolische Maschinen. Die Idee der Formalisierung in geschichtlichem Abriß, Darmstadt 1988

[24] Studio 31 (undated), The Musical World Beyond Twelve, in: projektstudio31, accessible online: www.projektstudio31.com (accessed 20 November 2019)

[25] See Susan Blackmore, The Meme Machine, Oxford 1999

[26] Friedrich Kittler, Aphrodite. Musik und Mathematik I, Teilband 1, München (Fink) 2006

A genealogy of *topoi* becomes truly archaeological (in the Foucauldian sense) when their grammar, or structure, is identified, as technical image (in Horst Bredekamp's sense). Geoge Kubler declared the form as decisive criterium in art history; Heinrich Wölfflin saw different art-historical epochs shaped by predominant formal features.[27] Art-historical research such as Warburg's Mnemosyne project, which is itself already a function of photographic image reproduction, became media-active archaeology of art with "DH" *avant la lettre*: the Census of ancient works of art known to the Renaissance on computer basis, applying binary image comparison as method on the basis of laser discs. Such a computer initiative has been preceeded by Oehler's project (with German computer industry Siemens) to automatize the metadata of photographies of ancient Roman sculptures (Monumenta Artis Romanae) at the Forschungsarchiv Römische Plastik (University of Cologne)[28]. A more recent effort in that direction has been film maker Harun Farocki's project *Suchbilder*.[29]

So how can the insistence of certain technological configurations, which stay almost invariant towards cultural contexts, and historical change, be explained? Can an archaeology of the computer screen be derived from the Western tradition of screen functions as a window into a virtual space?[30] No technological imperative leads from digitisation to the rectangular screen as human-computer interface (HCI). Below cultural semantics (the iconology of images), "the digital image is an aggregate of quasi-autonomous, independently addressable, numerical fragments. [...] new media are not constrained by the rectangular frame."[31] The insistence of the cinematic screen, down to the smart phone interface, may thus be seen "as a cultural lag, rather than a technological imperative" (ibid.). Once it is observed from the inside of technology, the "frame" is rather replaced by the matrix as a mathematical figure, which became material technology with the rectangular magnetic core memory for storing an image in early digital computers.

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[27] See W. E. / Stefan Heidenreich, Digitale Bildarchivierung: der Wölfflin-Kalkül, in: Sigrid Schade / Christoph Tholen (eds.), Konfigurationen. Zwischen Kunst und Medien, Munich (Fink) 1999, 306-320

[28] See Hansgeorg Oehler, Mise sur ordinateur d'une documentation photographique sur la sculpture romaine, in the UNESCO journal: Museum, vol. xxiii, no 1 (1970/71), 37-43 / „Electronic documentation of a collection of Roman sculpture photographs“, 46-51

[29] W. E. / Stefan Heidenreich / Ute Holl (eds.), Suchbilder. Visuelle Kultur zwischen Algorithmen und Archiven, Berlin (Kadmos Kulturverlag) 2003

[30] See Lev Manovich, Towards an Archaeology of the Computer Screen, in: Cinema Futures: Cain, Abel or Cable?, edited by Thomas Elsaesser / Kay Hoffmann, Amsterdam (Amsterdam University Press) 1998, 27-43

[31] Mark B. N. Hansen, New Philosophy for New Media, Cambridge, Mass. (M. I. T. Press) 2004, as paraphrased in: Kjetel Jakobsen, Anarchival Society, in: Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010, 127-154 (146)

Lev Manovich interprets the possibilities of such interfaces as prefigured already by the cinematographic avant-gardes of the 1920s, in their experiments with jump cuts, animation and collage. According to Manovich, the avant-garde anticipated digital aesthetics.[32] But a close look at a magnetic core memory from a vintage computer RAM reveals that it is *not* just aesthetic strategies which became embedded in the commands and interface metaphors of computer software. The modernist strategy of collage "reemerged as a 'cut and paste' command, the most basic operation one can perform on digital data."[33] The so-called "post-cinematic image" is different from the cuts and jumps and interactivity in computer games.[34]

How does the transmission (*alias* cultural "tradition") of techno*lógos* occur, across "historical" time, and geographical space? Radio and television emerged in different countries in almost parallel ways, on an almost identical engineering basis, derived from scientific research on the physical nature of electromagnetic wave propagation. Ideo-logical differences were rather expressed by the content of the broadcast programs. While there has been a long translation barrier for relevant texts on philosophy of technology to cross national language barriers, the world of techno-mathematical engineering, with its cross-cultural communication of diagrams and symbols, has wired artifacts into standard operations almost immediately, whereas computer viruses, by online connection between computers, cross national boundaries like memetic units.[35] The "language" of so-called new media which obviously refers to electronics driven by the binary code, is not just what interfaces offer to the human user, it is its machine language on the operative level of machine programming.

Distinctive Technical Definitions by Media Archaeology

Media archaeology is the complementary method (if not antithesis) to media phenomenology. It does not focus on media on the level of their surface effect on humans or their more sublime affective impact *via* interfaces, but rather uncovers the hidden agenda of technomathematical artefacts, or better: artefactuality, focussing on temporal and time-critical configurations.[36] Whereby to most human

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[32] Lev Manovich, The Language of New Media, Cambridge, Mass. (The MIT Press) 2001, 78 f.

[33] Lev Manovich, What is digital cinema?, http://www.manovich.net/TEXT/digital-cinema.html, accessed January 2011; see idem, Engineering Vision: from Constructivism to the Computer (The University of Texas Press), forthcoming

[34] See Benjamin Bigl / Sebastian Stoppe (eds.), Playing with Virtuality. Theories and Methods of Computer Game Studies,Frankfurt/M. (Peter Lang 2013

[35] See Jussi Parikka, Digital Contagions. A Media Archaeology of Computer Viruses, New York et al. (Peter Lang) 2007

[36] "Nicht [...] eine ableitende Begründung, sondern [...] aufweisende Grund-Freilegung": Martin Heidegger, Sein und Zeit, 15th ed. Tübingen (Niemeyer) 1979, 8

users media are opaque technology - "present-at-hand" (*vorhanden*) in Heidegger's vocabulary -, media archaeology tries to make technology transparent for analysis, that is: "ready-to-hand" (*zuhanden*) in Heideggerean terms. Just like the "external form" of software, as interface appearance, differs from its "inner form" as source code, and comparable to the figure / ground dichotomy which has been applied by Marshall McLuhan from Edgar Rubin's and Max Wertheimer's *Gestalttheorie* to media-theoretically[37], media archaeology separates the phenotype from the genotype of technology.

Media archaeology at first sight is about technological architectures, but it is concerned with media not only on their structural but as well on their processual level, thus becoming post-structural, or *operative* diagrammatics. This vector sets media theory apart from semiotics and closer to the analysis of signal processing. A signal, in the physical definition, is the material embodiment of a message respectively information *in time* - that is, with time as the variable of functions under analysis.

Technological media themselves have an enfolded, implicit knowledge of the physical and mathematical world which differs from human perception. Media archaeology here takes, hypothetically, the point of view of media as well. The length of numbers in binary notation, which is at least double that of numbers in the decimal system, "makes the binary system impractical for human calculators, but it does not upset computers in the least. From the computer's point of view, these sequences of 1 and 0 are convenient, for they are easily codified in electric signals; the passage of current expresses 1, its interruption 0"[38] - which perfectly corresponds with a binary switch in the real world of electronic which was available "at hand" in times of the mathematician and engineer Claude Shannon: the electromagnetic relay. What started with the electro-mechanical relay then resulted in electronic flip-flop circuits first on vacuum tube, then an transistor basis. Different from *ternary* switching, it is "easier to work in the scale of two than any other, because it is easy to produce mechanisms which have two positions of stability; the two positions may then be regarded as representing 0 and 1"[39].

Written and read carefully, there is media *archéology.* In ancient Greek, *arché* splits into a temporal and a functional meaning: *origin* on the one hand, and *command* on the other. Misunderstandings should be avoided here. Instead of "media archaeology", should one not rather write

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[37] Marshall McLuhan / Bruce R. Powers, The Global Village. Transformations in World Life and Media in the 21st Century, Oxford et al. (Oxford University Press) 1989

[38] Denis Guedj, Numbers. The Universal Language, London (Thames & Hudson) 1998, 59

[39] Alan Turing, Lecture to the Mathematical Society on 20 February 1947; printed in Vol. 10 in the Charles Babbage Institute Reprint Series for the History of Computing, A. M. Turing's ACE Report of 1946 and Other Papers, The Massachusetts Institute of Technology, 1986, 106-124 (114)

"prehistory of media"? The term *prehistory* implies a certain teleology that is alien to technology.[40] The prefix "pre-", though, does not just refer to a "before" in its temporal, historically lineare sense, but rather to a structural pre-condition as well. This pre-structuring "before" can happen in nonlinear modes (as described in René Thom's theory of catastrophy) just as there are electro-dynamic processes which are ultra-sensitive to slightest changes which result in a complete re-organisation of the whole system. Narrative historiography fails when it has to explain nonlinear, contingent events in the past[41], such as on 9th November 1989 when the erroneous answer by Günter Schabowski, spokesman of the GDR government in East Berlin, when asked in a press conference about the timing of the new, liberal rule for citizens to travel, without bureaucratic delay, outside the enclosed state. Schabowski's verbal answer "immediately" (German "sofort") corresponded with the electromagnetic immediacy of live transmission in radio and TV, thus turning the word into electronic flash as signal event, which immediately arrived the audiences on TV and radios. This triggered an immediate mass-migration to the intra-Berlin gates, before the military apparatus could be instructed in advance, resulting in the sudden opening of the Berlin wall. Such a contingency can not be formulated in terms of historical discourse at all, but this does not lead to agnosticism. Instead, a modelling of mathematical probabilities is the dynamic answer to that question.

Conclusions on Technology-Biased Media Archaeology

Media archaeology refers to the past insofar as it recognises the temporal conditions of the possibility for current media operations, which means: being (still) at work. Different from history of technology or Science and Technology Studies, the emphasis is not on discursive differences, but on transhistorical techno-logical insistance. *Techné* as revelation, in the Heideggerean sense, does not only "bring forth", but as well *makes present*.[42] The media-archaeographical description of an old Edison phonograph or an early home computer aims not at historicizing, but revealing "the deep physical and structural operations" of the device, as a material *arché* technical *lógos*. Such archaic precedence is not historical but media-epistemologically enduring. The temporal category "past" thus appears rather like a temporal function of a present process, as an unfolding of presence-in-action, in the mathematical sense of an event: Fourier Analysis (for signals) and Markov Chains (for discrete character strings).

Media archaeology is not a simplification, but an analytical reduction to techno-logical essentials and *principles* (the Latin equivalent to *arché*);

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[40] David A. Mindell, Between Human and Machine. Feedback, Control, and Computing before Cybernetics, Baltimore / London (Johns Hopkins University Press) 2004, 6

[41] Ludolf Herbst, Komplexität und Chaos. Grundzge einer Theorie der Geschichte, Munich (C. H. Beck) 2004, 213

[42] As accentuated by Sobchack 2011: 324

when Hermann Helmholtz published his seminal *Lehre von den Tonempfindungen* in 1863, the subtitle declares a kind of sonic archeology: the "physiologische Grundlage", that is almost literally: *arché* (foundation), for the theory of music. In this sense Milton S. Kiver's book *Television simplified* (New York 1946) does not teach the appropriate use and consuming of TV programs but the precise description of its inherent electro-technology.

According to the media-archaeological *credo*, technological structures become especially evident in its beginnings: "It is the beginnings of invented things, which appeal to me", writes Lance Sieveking (who wrote one of the first televisoin dramas transmitted by the BBC), and explains: "For it is a their beginnings, that we may detect their true nature", that is: their epistemological essentials. Sieveking is quoted here from the epitaph of the Memoirs of John Logie Baird[43], which is a very archaeological insight into first steps of the electro-mechanical television apparatus itself. "In principle, the *televisor* is both simple and ingenious", comments the brochure accompanying the model kit *The Televisor*, developed as teaching device by the Middlesex University.

Media archaeological aesthetics is an explicitly *archaic* media experience. The archaic, besides its temporal meaning ("origins"), refers to a structural element, to the dominant (*arché*), essential features of a medium system. At the same time, aesthetically it means its reduction to the essential, the elementary bits, a "rarification" of discourse in Foucault's sense. What tends to be mystified as a new kind of "intelligence" in the discourse on "deep" machine learning, can be made explainable again by simply programming and implementing a neuronal network, such as an associative memory pattern recognizer, in fewer than 250 lines of BASIC on a Commodore 64 home computer, and by identification of its core code instructions.[44]

With an ever increasing differentiation in the various media-archaeological approaches, there remains a common determination for focusing on the material basis of every media communication, and its non-linear chrono-logics. Media archaeology thereby inherits the bias of McLuhan's emphasis on the technically induced medium message, rather than is mass-communicative content. Different from historical media archaeology which pays respect to the cultural, and social aspects of media, the more techno-radical media-archaeological effort is to liberate, or at least suspend, past hardware from its premature absorption by the predominant discourse of history. It lets technical artifacts from the past

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[43] Television and Me. The Memoirs of John Logie Baird, *e*dited by Malcolm Baird, Edinburgh (mercatpress) 2004

[44] John Walker, Neural Network on a Commodore 64 [September 4, 1987], https://www.fourmilab.ch/documents/commodore/BrainSim, accessed January 2, 2024

be re-enacted in the present ("re-presenced"[45]), such as in the emulation of vintage computers. A different sense of techno-logical temporality arises here, in the operative chronosphere between precise time-critical material media processes (*kairotic* time), and virtually timeless code (*aionic* time).[46]

MEDIA ARCHAEOGRAPHY

Different from the Narrative Organisation of Data Events: Archaeography

The digitisation of paper-based archives from the past not only affects textual criticism and philological research by new "Digital Humanities" options of accessablity and addressability of "big data" strings and by intelligent search algorithms. Even image and sound collections, where the video recording and phonographic signals have escaped verbal taxonomies so far, become "logified" by digitization. Born-digital objects belong to the symbolical regime of computation right from their moment of coming into being. Media archaeological analysis focuses on the micro-temporality in operative data processing, and reformulates the macro-time of what has been known as cultural history in different terms. The literal quantisation of time signals, just like Fourier Analysis of wave forms before, replaces the time domain by numerical frequencies.[47] Archaeography practices an alternative form of minimal, serial time-writing (or rather registering), closer to the programming of computers itself.[48] Computers practically transform narrative aesthetics into non-discursive, algorithmic configuration of events. Current culture begins to acknowledge this different kind of chrono-*lógos*.

Writing Technology: Media Archaeography

Next to media-archaeological analysis, remains the challenge to develop a language to appropriately describe the electronic circuitry and the algorithms which are active within media (art): media archaeography. Media archaeography practices alternative models of writing the being of

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

[46] On *kairotic* and *aionic media* time, see Siegfried Zielinski, Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means, Cambridge, Mass. (M.I.T. Press) 2008

[47] See Friedrich Kittler, Draculas Vermächtnis. Technische Schriften, Leipzig 1993, 200

[48] See Moritz Hiller / Stefan Höltgen (eds.), Archäographien. Aspekte einer Radikalen Medienarchäologie, Berlin (Schwabe) 2019

technologies in time: their governing principles, their archaic essentials, their variabilities and invariances.

Media archaeology addresses the field of new media art suspended from the (art) historiographical narratives which immediately place such works in its discursive contexts, in favour of other temporal constellations and short-cuts between the present and the past. It is on the operative level that media archaeology differs from the discourse of history: "Unlike contextualism, media archaeology's aim is to set these objects as potentially *transhistorical* - that is, not necessarily context dependent."[49]

Media archaeology does not narrate, because machines do not tell stories, they transduce and count signals. Algorithmics precedes narration. Jean-Luc Godard chose to change his medium from textual writing to video editing when creating his *Histoire(s) du Cinema* as an artistic attempt of media archaeography. Not just another method to conceive the history of technology, media archaeology faces the vibrant chronopoetics of media as an alternative to the discourse of history itself. Media historiography and media archaeology, to a certain extent, are incompatible in the most productive way; they are fundamentally different approaches to the temporal layers of technological media and their human condition. As retrospective archaeography of current media culture, "[a] robot historian would write a different history than would its human counterpart"[50]. It is essential to media archaeology as method to take (or simulate) the techno-mathematical point of view of the media themselves. Media archaeology as academic method is performed by humans; but there are cases where the media themselves all of the sudden actively become the archeologists of past signals and data, be it numerical, texts, acoustic or optical. When Samuel Beckett's one-act drama *Krapp's Last Tape* was performed in 1959 on the theatre stage, the main protagonist was a magnetic tape machine, confronting the human actor with his own voice from years ago - veritable "media theatre". In media-acoustic research, the human voice itself turns out as a technical function.

While conventional media historiography as symbolic organisation of cultural time tends to privilege linear evolutions of the type "from abacus to computer", media archaeology diagrammatically imagines non-linearities and anachronistic re/turns. The so-called "digital" does not simply emerge after analogue, that is: signal recording media like the phonograph or wireless radio but has been there already: in telegraphy with dots and dashes, and above all, with alphabetic writing. And analogue computing is not just a dead end in the history of calculating machines, but the method of "thinking anlogue" remains a genuin alternative to algorithmic numerical data processing. Dutch music

[49] Sobchack 2011: 329

[50] Manuel de Landa, War in the Age of Intelligent Machines, New York (Zone Books) 1991, 3

composer Hans Kulk demonstrates how to generate music on an analogue computer, thus reminding of the sisterhood of analog computer and musical synthesizer, such as his composition *North-West* (December 2002).

Non-Historical Media Temporalities

In media culture, there is an increasing uneasiness with the dominant historiographical model of organising knowledge about past times, in favour of recognising non-linear temporal interrelations: the "temporal fold" (Deleuze referring to Leibniz) "recursions" (Kittler); "resonance" (McLuhan). Entropy as the physical law of one-directional time (the temporal arrow) came into existence not by emphatic philosophy of history (such as G. W. F. Hegel's) but by Hegel's contemporary Carnot who theorised about the minimal energy loss in machine work. In the information age, Shannon's mathematical definition of digital information for communication engineering has since replaced the thermodynamic meaning of entropy.

TECHNICAL MEDIA MATERIALISM

What kind of *archéologie*? Media Materialism

Just occasionally, media archaeology is a hunting for "dead media" discoveries and reverse engineering such as Semen Karsakof's 1832 design for an "intellectual machine"[51]. Media archaeology describes moments when media themselves, not exclusively humans any more, become "archeologists" of epistemic objects, like practiced in so-called "content-based" image and sound retrieval in media-archival data banks. Somewhat beyond Marshall McLuhan, media are not just extensions of men any more but have become autonomous, beyond body-related cultural techniqes such as religious rituals or hand-writing practices in a broader sense. Media are not just objects of media-archaeological analysis, but as well active "archaeologists" of a different kind of knowledge themselves (understood here in Bruno Latour's sense of "non-human agencies).

While sharing with the classical archaeologicst the attention of the material artefact ("hardware"), the essence of media archaeology comprises the *operative*, processual mode of technological media as well. Radical media archaeology is no historicist recurrence to "dead media" but investigates the fundamental techno-logical configurations of the present as continuous past. As a method, it is an effort to reveal the non-disursive *archive* of the techno-logical present.

[51] Wladimir Velminski / W. E., Semen Karsakov: Ideenmaschine. Von der Homöopathie zum Computer, Berlin (Kulturverlag Kadmos) 2007

Present digital devices, even if minimised to the max, are still continuing the von Neumann architecture of storage-programmable computing. Therefore they rather trigger the media archaeologists' interest in the contemporariness of relics from past that the historicity of bygone times.

The accumulation of material traces of the recent technological past asks for redefining media-archaeological practice. The very notion of media "archaeology" has been stimulated by Michel Foucault's seminal *Archaeology of Knowledge*. Foucault is not to blaim for reducing the term "archaeology" to a metaphor; Foucault has rather been frequently misinterpreted by archaeologists and cultural historians. Foucault on several occasions distanced himself from a literal interpretation of *archèologie* as digging metaphor or as reference to geological layers; he rather reactivated the need for a "philosophical archaeology" (as once expressed by Immanuel Kant) which means an inquiry into conditions of possibility for cognition (the *a priori*).

According to Kant's fragmentary application for an academic *concours* on the progress of metaphysics, the structure of philosophical reason (its *a priori*) escapes narrative event-focused historiography, and requires an alternative archaeographic "scheme" (diagram) instead to trace the path dependencies of reason across time - even a "mathematical" description.[52]

Blending such archaeology with the archive, rather than searching for "origins", Foucault's *archivology* discovers the system that governs the appearance of statements as unique events. For years, though, the rather abstract *a priori* in Foucault's archaeology of knowledge still lacked a more material grounding, while materialist media studies insist on hardware analysis. Today is the technological laws which govern what can be multi-medially expressed, communicated, stored and transmitted. The computational coupling of hardware and logics resulted in the kind of "general archival system" aimed at by Foucault's discourse analysis, which in the digital present is *online* access to the Internet of communication and things.

Archaeology, in Michel Foucault's notorious definition, questions the already-said at the level of its existence: the enunciative function that operates within it, the discursive formation, and the general archive system to which it belongs. This general archive can be specified, media-archaeologically, to the techno-logical condition: "The archive is first the law of what can be said, the system that governs the appearance of statements as unique events."[53] Archaeology in its traditional sense refers to the material

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[52] Immanuel Kant, Von einer philosophirenden Geschichte der Philosophie (1793), in: Ebeling / Altekamp (eds.) 2004, 33-35 (33 seq.)

[53] Michel Foucault, The Archaeology of Knowledge [FO 1969], transl. A. M. Sheridan Smith [1972], London / New

or substance of which cultural artefacts consist. For Foucault, archaeology is aware rather of the enunciative level of what happens; an enunciation is what is *not* immediately visible, rather geno- than phenotextual.[54] It is not a relation between surface and deep ground, but rather a Moebius-loop-like dynamics of back and forth.

When the Foucauldean term is applied to the genealogy of media, thus performing a *media archaeology*, his somewhat vague notion of the "discursive formation" suddenly can be addressed in positive and precise technomathematical terms. Media archaeology performs a technological micro-epistemology, that is: disovering, analysing and describing the epistemological sparks which spring from the most concrete level of technology itself, such as the delicate circuitry of the electronic saw-tooth signal generator which creates the jumps of single cathode ray lines within a television set in order to achive the impression of a cohrent image for (lagged) human perception at all.[55]

What predominantly counts in information processing media is not its material support; therefore no more archaeology in the classical sense is required but rather cybernetic archaeo*logistics*.

While multi-media aesthetics is a surface effect, digital signal processing is its media-archaeological generative law. The techno-mathematical essence of computing is its electric fluidity and switching circuits.

Such is the media *archive* in Foucault's sense (who uses this word in French in the singular mode, not to be confused with the classical state archive which in French is *plurale tantum*, notably *archives*). As opposed to structural laws, the media-archaeological *archive* is dynamic: all the difference between an algorithm as a symbolical mathematical notation and its implementation as running program in real hardware.

What is the relation between the phenomenological surface of media and their concealed technological condition? Whatever appears on the computer screen is a direct expression of its algorithms and codes (though disguised under audiovisual metamorphosis). It is the emphasis on *semiosis* which differentiates Charles Sanders Pierce's semiotics from straightforward structural linguistic semiotics, that is: the processual relation between signifier, signified and the "interpretant". One catches this on the tactile level of computer interfaces: Whenever an alphanumeric symbol on the keyboard is pressed as part of a string (a word, a sentence, a text, a formula, a graphic notation), the "sign" (the

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York (Routledge Classics) 2002, 145

[54] See Walter Falk, Vom Strukturalismus zum Potentialismus. Ein Versuch zur Geschichts- und Literaturtheorie, Freiburg i. Br. / Mnchen (Alber) 1976, 310 f.

[55] See A. J. Klopow, Grundlagen der Fernsehtechnik, bers. und ergänzt v. P. Neidhardt, mit e. Geleitwort von Manfred v. Ardenne, Berlin (VEB Verlag Technik) 1956, chapter 5 (50-99)

single letter) transforms into a electro-physical signal.[56] A transformation (or even "transsubstantiation" in the theological sense) takes place. When this passage of symbol into signal takes place, it looses all its semantical referentiality and becomes a coded element within a (physically) real word - loosing "meaning" while gaining "indexicality".

Media Archaeology in Alliance with Prehistorical and Processual Archaeologies

It is by epistemic necessity that there is a close affinity between radical media archaeology and *pre*historical archaeology as such - understood as the investigation of material culture in the absence of textually coded *lógos*. Knowledge of media pre-history is not unearthing the primitive, but rather an archaeology of the present techno-logical condition. It is mainly prehistorians which recently turned to an archaeology of the present or even future challenges, such as nuclear waste site preservation.[57]

Media archaeology operates with a different tempor(e)alty of material things. Still, there is a clash between the anthropocentrism of academic archaeology (focusing human performance) and *media*-archaeological notions of non-human agency (operativity) and technological *eigenzeit*: Here, the real protagonists are rather the machines than the people who created them.[58] Inventors should be mentioned, but their creations are controlled by some rather external machinic logic. Media can be studied without people"[59] - in *radical* versus *historical* media archaeology.

In affinity to so-called processual archaeology, between hermeneutics and cultural semiotics, media archaeology as well is less concerned with the human behind the artistic or technical artefact, but rather with the techno-logical system embracing both[60], oscillating between agency and structure in analysing operative *lógos*. As soon as the operative quality of an artefact is known, it is no longer silent.[61]

Is it mandatory to defend the "monumental" approach of archaeology *versus* making it speak as "document" for something else in the hermeneutic sense. What "speaks" in technological action, is its *lógos*. The very term technology can be deciphered in this sense. *Lógos* and *techné*, words and material things, in Foucault's sense are not

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[56] As emphasiced in: http://www.agis.informatik.uni-bremen.de/ARCHIV/Publikationen/BegegnungenImZeichen.pdf

[57] E-mail Cornelius Holtorf (Archaeology, Department of Cultural Sciences, Linnaeus University, Kalmar, Sweden; see http://web.comhem.se/cornelius), 7th January, 2015

[58] Friedrich Kittler, Optical Media: Berlin Lectures 1999, trans. Anthony Enns, Cambridge (Polity Press) 2010

[59] John Durham Peters, Introduction: Friedrich Kittler's Light Shows, in: Kittler, Optical Media, 5

[60] Kent V. Flannery, Culture, History vs. Cultural process: A Debate in American Archaeology, in: Mark P. Leone (ed.), Contemporary Archaeology. A Guide to Theory and Contributions, Carbondale 1972, 105

[61] Ian Hodder / Scott Hutson, Reading the Past. Current Approaches to Interpretation in Archaeology, Cambridge, 3rd ed. 2003, 5

documents to be read, but monuments[62] - mapped on the technological mediascape. It is for this reason that Foucault did not label his inquiry "historical" but "archaeological".

Media materialism: Cultural technologies and Nietzsche's typewriter

Conceptual media archaeology is neither about re-discovering the losers in media history for a kind of Messianic redemption, but rather an effort for in-depth insight into the principles of technological events. Therefore, media archaeology reminds of the hardware material or software logical substance of which media is made or consist. Digital archaeology operates below sight and sound, and is therefore not immediately accessible to human senses. The very term "digital" refers to the archaeological meaning of computing, its hardware relays, signal processing by electric fluidity and swichting boards.

Inbetween stands Lev Manovich's notion of "cultural software". Manovich separates between the cultural and the technical level in computing; the term "cultural engineering" (German *Kulturtechniken*) links both.

Media archaeology focuses its cultural analysis to techno-cultural engineering, which differentiates it from the more discourse-oriented Cultural Studies. At this point media archaeology exposes the technicality of media not in order to reduce culture to technology, but applying what is known in textual studies as "close reading" to the analysis of mediated and mediating processes, in order to reveal the epistemological momentum in technology. The aesthetics of "loops" in popular music or video art, for example, are a product of the technology itself, resulting in a specific sense of repetitive temporeality in contemporary media culture.[63] A technical notion like "real time", on a discursive level, is commonly confused with synchronicity and "live" transmission like in radio and TV, but is rather a simulated presence: the time-critical processing of an complex event in digital space for what the human perception still conceives as "present".

Media archaeology takes as its actual model and point of departure the digital condition of contemporary culture, by opening the horizon ranging from the elementary ancient Greek vocal alphabet across Raimundus Lullus´ combinatorial "memoria artificialis" which operates with the idea of the discrete, stochastic "alphabet" of terms[64], up to the operative

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[62] The Archaeology of Knowledge, transl. by A. M. Sheridan Smith, N. Y. 1976, 7, 106-117, 138-139

[63] See Tilman Baumgärtel, Schleifen. Geschichte und Ästhetik des Loops, demnächst Berlin (Kulturverlag Kadmos), 2015

[64] Sybille Krämer, Symbolische Maschinen: die Idee der Formalisierung in geschichtlichem Abriß. Darmstadt 1988, 88

algorithms of digital computing.

Marshall McLuhan underlines that the "archaeological" analysis of scientific research is itself a by-product of the Gutenberg era of printed, discrete letters; analysis in fact operates by de-composing a text into single elements (*elementa*, or even *stoicheia*, the Greek expression for both single alphabetic letters and atomic units in nature). It has been a crucial moment - rather archaeological than historical, since not immediately reflected in cultural terms - when the invention(s) of the discrete alphabet (as opposed to ideographic writing systems like the Egyptian hieroglyphs) cut down the human language into smallest elements which are meaningless in themselves, from house (*beth*) to "B", so to say. At this moment the machines take over, since only machines can perform symbolic operations without any semantic referentiality (which hinders effective data processing) at all, purely syntactically.

The discrete alphabet materially refers to a prominent media-archaeological artefact. A small exhibition at Weimar 2002 grounded so-called Weimar culture as rupture between classicism (Goethe) and modernism (Nietzsche) in two media-archaeological artefacts: Goethes mechanical pencil and Nietzsche´s typewriter. Different kind of content has been produced by such different devices, as explicitely expressed by Nietzsche: "The writing instrument co-produces our thoughts." Media technologies are not simply functions of historical and cultural discourses. On the contrary, the French *Apparatus* theory, notably Marcelin Pleynet, took account of the ideological *a priori* (in the Kantean sense) of the technical apparatus: "[...] l'existence non significante d'un appareil producteur d'images, qu'on peut indifférement utiliser à ceci ou à cela, à droite ou à gauche. [...] les cinéastes auraient intérêt à s'interroger sur l'idéologie que produit l´appareil (la caméra) qui détermine le cinéma"[65], for instance "une caméra productrice d´un code perspectif directement hérité, construit sur le modèle de la perspective scientifique du quattrocento" (ibid.).

For an analysis of the hardware of Nietzsche's typewriter itself (housed in the Weimar Classic Collection), an operative analysis could not be accomplished by textual hermeneutics of the resulting typescripts exclusively, reading the texts which Nietzsche produced. It is the mechanism and symbolic order of his typrewriter itself which produced his co-called "nonsense-poems", proving that Shannon was right when in his theory of information he declared that semantic aspects do not matter to techno-mathematical engineering.

The Antiquarian Impulse in Media Archaeology

[65] "Économique, idéologie, formel ...", in: Cinéthique no. 3 (1969), 10

Different from an archaeology of "dead media" from the past, radical media archaeology focuses on actual mathematics, on the operative diagram embedded in hardware, on signal processing transcending pre-technological cultural techniques.

Media archaeology, in its epistemologic understanding, only occasionally is about digging out obsolete media from the past or to remember alternatives to existing technologies. Media Archaeology defends the "antiquarian" approach to machines and automata indeed, as way of very haptic reexperiencing technological materialities from the past, even if antiquarianism in nineteenth und 20th century came to be considered antiquated itself and has been replaced by philosophies of cultural history as background discourse for research into past materialities. Antiquarians once practice(d) what the archaeologist Eduard Gerhard once successfully termed "monumental philolology", which became "forensic analysis" in terms of Matthew Kirschenbaum. The new art of such closest reading is media philology.

Bruce Sterling's "Dead Media Handbook Project" (initiated 1995, conceived for the Internet, nowadays non-functional itself) cared for the redemption of otherwise forgotten technologies. Sometimes scholars take the term "media archaeology" at face value, almost metaphorically referring to the "digging out" of forgotten machine visions of the past, of antique or baroque media design which was never materialized, which has remained a singular effort, or which are simply forgotten today. But even if "[...] media archaeology [...] in a pragmatic perspective means to dig out secret paths in history"[66], this is not meant as historicist musealization, but turns towards "prospective archaeology"[67].

With the *Telharmonium Press* in Hollywood, California, Garnet Hertz in 2009 published a book in the spirit of Sterling's *The Dead Media Handbook*, entitled itself in an "antiquarian" fashion of an 18th century book: *A Collection of many Problems Extracted out of the Ancient and Modern Philosphers: As, Secrets and Experiments in Informatics, Geometry*, Cosmography, Horologiography, Astronomy, Navigation, Musick, Opticks, Architecture, Statick, Mechanicks, Chymistry, Water-Work, Fire-Works, etc., Wherennto is added, Dead Media. Choosing by chance (that is: by random access) any of these items, one finds, e. g., the switch-board of an early computer installation in an office. The book is supplemented by scraps of indented paper stripes which apparently is Morse code. What is declared as "dead media" here, in this case can principally be reenenacted (thus: deciphered, read, sonified). That is the

[66] Siegfried Zielinski, Media Archaeology, published November 7, 1996, in the journal CTHEORY, http://www.ctheory.net/articles.aspx?id=42 (accessed May 2, 2019)

[67] Siegfried Zielinski, Prospektive Archäologie, in: Moritz Hiller / Stefan Höltgen (eds.), Archäographien. Aspekte einer Radikalen Medienarchäologie, Berlin (Schwabe) 2019: 47-62

difference to ancient sculptures or other traditional archaeological artefacts. Melancholy is the expression of nostalgia for something we long for but can not reach any more, since it is irreversibly gone. The media-archaeological approach is non-melancholic though, since past media are not dead, but un-dead, principally to be re-activated and thus in a radically present state of latency. Such media-archaeological artefacts are embedded in another temporal logic which defies historical discourse: They remain in latency just like a voice recorded on magnetic tape; at any moment, though, they can be re-activated, signals as a function of time. Different from a more historical media archaeology, which is familiar to cultural studies by bringing "dead media" knowledge back to consciousness in contemporary digital media culture, radical media archaeology rather experiments with writing media time in non-historiographical terms.

There is no "dead" media

Far from simply "excavating" material knowledge of technologies past, media archaeology can not be reduced to unearthing "dead media" as once described by Bruce Sterling - although this impetus is one of its driving components. Among *A Collection of many PROBLEMS. Extracted out of the Ancient and Modern Philosophers: As, SECRETS and EXPERIMENTS in Informaticks, Geometry, [...] Whereunto is added, DEAD MEDIA*, edited by Garnet Hertz[68] is a segment of metal "recording wire" which once was used for electromagnetic sound recording, a kind of mnemonic hair once wound around a reel. But the media-archaeological point is not in the artefact itself but in its operative coupling with the "field" it needs to be literally embedded in. A stripe of punched Morse code (which I found inserted in a previous edition of this *Collection*) might now actually be re-inserted into a reading mechanism which can decipher the latent message. The piece of wire most probably magnetically stores a voice or piece of music recorded decades ago; when inserted into a working Wire Recorder (re-activated, maybe, from a technical museum), one might all of the sudden perceive voices from bodies which probably have passed away already. This experience is not about dead media, but about media as being undead - a latency wainting to be processually activated. There is an untimeliness of media which is incorporated here.

When simply exhibited in a museum, an old Edison phonograph is dead matter indeed, a cultural artefact but not a medium. Once an Edison cylinder is played on it, Enrico Caruso's voice might be heard, however noisy. Only when in operation a technical device is really in its medium state, a "medium in being", and then something radically present takes place. Media-immediacy is ahistorical by its signal processing (and

[68] Edition Two, Telharmonium Press, California, 2010

human perceptional) nature. Watching an old analog video from Nam June Paik's days still grants the phenomenologically experience radical presence - which is the affective power of such media.

Media-active archaeology

Analytic technologies can be considered media-active "archaeologists" themselves, once they reveal epistemic structures and aesthetic processes which had been rather unknown to human-centered cultural investigation before.

Media archaeology is a form of generating knowledge with the media themselves as active agents respectively archaeologists, like digital signal processing which restored early "phonographic" records of John Logie Baird's experimental electro-mechanical television. It is a gesture of "open source" (de-constructing hardware) not only in the sense of public usage of source codes in programming, but as well in the sense of dis-mantling media from their designed enframing, like "platform studies" perform it.

Archaeological media materialism

Siegfried Zielinski argues for a "philology of material things"[69] - a reminder of the term "monumental philology", once coined by Eduard Gerhard for the method of classical archaeology in the 19th century. To analyse a material technical artefact in its own terms (as *monument* in terms of Foucault) differs from deriving this evidence from the accompanying texts - unless reading circuitry diagrams. As a partial off-spring of the literatures department, media archaeology practices techno-material and techno-mathematical philology, material *aisthesis*.

An approach close to the materiality of media is akin to Classical Archaeology which deals with the material remains of a culture (as opposed to textual hermeneutics). But the archaeological metaphor can be seductive. Admittedly, a certain nostalgia for so-called "dead media" (Bruce Sterling) and "the analogue" is a driving bias, but this melancholy should be kept private. Media archaeology is n o t about beginnings, about origins in the temporal sense, but rather about the *arché*, the laws governing media in action. These principles are rather structural than temporal, though it happens that at its emergence a medium most openly reveals its structures before it becomes dissimulated by interfaces.

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[69] In his book (Berlin 2012) *Jenseits der Medien* ("beyond media")

Media Archaeology and / or Media Phenomenology

Media archaeology and -archivology is a machine- and code-centered form of media studies indeed[70], rooted as much in Foucault's definitions[71] as it is connected with Marshall McLuhan's turn against content-oriented media analysis. For some time, the field of new media theory seemed split between two very different approaches: While media archaeologists "describe the non-discursive practices of the techno-cultural archive", media phenomenologists "analyze how phenomena in various media appear to the human cognitive apparatus, that is, to the mind and senses"[72]. In the discussion of, e. g., what is an "image" in the age of new (that is, electronic and digital) media, phenomenology, in an explicit Bergsonean tradition, insists on the coming-into-being of the mediated image in the "enframing" acts of the human bodily cognition.[73] More recently, though, media phenomenology goes beyond: New technologies of sensation have come into focus that connect to the environment in pre-perceptional immediacy, a media sensibility that "falls out of the scene of human perception"[74]. In order to grasp such non-perceptional sensibilities, radical media archaeology as a form of "posthuman cultural studies"[75], rather takes the point of view (*theoría*) of the machine itself.[76] Non-discursive media archaeology is going "back to the roots" (Greek *arché*) in three ways: to the technical archive (in order to identify the time-critical *momentum*[77]), to its temporal horizons (multiple "beginnings"), and in the sense of the mathematical square root "√" as a constitutive force in algorithmic, techno-mathematical media.

"Back" to the roots: identifying the techno-logical core

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[70] As expressed in Wendy Hui Kyong Chun, Introduction. Did Someone Say New Media?, in: New Media, Old Media. A History and Theory Reader, eds. Wendy Hui Kyong Chun / Thomas Keenan, New York / London (Routledge) 2006, 1-10 (4)

[71] The archive "governs the appearance of statements as unique events", whereas archaeology "questions the already-.said at the level of its existence [...] and the general archive system to which it belongs": Michel Foucault, The Archaeology of Knowledge, New York (Tavistock) 1972, 129 and 131

[72] Kjetil Jakobsen, Anarchival Society, in: Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010, 127-154 (141)

[73] Mark B. N. Hansen, New Philosophy of New Media, Cambridge, Mass. (MIT Press) 2004, 13. See Henri Bergson, Matter and Memory, New York (Zone Books) 1988, 35 f.

[74] Mark B. Hansen, Feed-Forward. On the Future of the Twenty-First Century Media, Chicago / London (University of Chicago Press) 2015, 273, note 12

[75] Geoffrey Winthrop-Young, Cultural Studies and German Media Theory, in: Gary Hall / Clare Birchall (eds), New Cultural Studies, Edinburgh (Edinburgh University Press) 2006, 88-104 (100)

[76] In their introduction to *Critical Terms for Media Studies* (Chicago 2010), the editors W. J. T. Mitchell and Mark B. N. Hansen take the title of Marshall McLuhans seminal *Understanding Media* (1964) at face value: understanding current culture from the perspective of media.

[77] See Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009

Media archaeological analysis (both academic and artistic) departs from the concrete "technical" (Simondon[78]) or "epistemic" (Rheinberger) object, such as the discovery of the enigmatic phenomenon of electro-magnetic waves. When evaluating such evidence, a methodic bifurcation takes place; a "Y" diagram of techno-temporal analysis is therefore proposed. "Cultural" studies, discourse analysis and humanities immediately then tend to (re-)locate such objects in historical contexts (such as, in the case of radio, vibrant spiritism and the "ether" fiction), thereby performing a historicist turn, oscillating between technical, cultural, and discursive aspects. Media archaeological analysis, on the contrary, rather remains *within* the technical configuration, going even deeper into the non-human, non-anthropocentric and non-societal signal event, radicalizing the epistemological inquiry into the techno-knowledge inherent in technology. When, e. g., Ali Grami's *Introduction to Digital Communications* reminds of interference occuring in every act of signal transfer ("No communication channel is ideal, and thus a message signal undergoes various forms of degradation. [...] a paramount goal in the design of a communication system is to overcome the effects of such impairments."[79]), techno-cultural analysis identifies, to what degree human-related notions of impairment or other "disabilities" may have derived directly from notions like "noise" or "signal distortion" in communication engineering.[80] Radical media archaeological analysis, in an ever closer reading of technical descriptions, relates this *momentum* to the implementation of the symbolic (code) into the (materially) real in technological media analysis, to the dynamic object of signal transmission in the media channel. It is here that "noise" emanates from without and within the physical, time-varying signal which channel coding seeks to counteract with mathematical intelligence.

While engineers aim to reduce technical noise by negative feedback correction, media-archaeological artist - which investigate media close to the signal - actually amplify it, in order to critically reveal the techno-logical drama which unfolds in the encounter of the symbolical with the real. Disruptive moments break the logocentric cultural desire of code-controlled nature. Once designed electronic circuitry or written source code is embodied in technical matter, an infinite possibility of electro-physical frictions arises. Even if there are no "errors" from the techno-logical point of view[81], all kind of glitches and noise occur. In "post-digital" aethetics and so called "aesthetic of failure" as proposed by sound designer and media artist Kim Cascone, it is "precisely these infractions that give code its real aesthetic value"[82]. The strictly computational approach even celebrates incompleteness arisen from

[78] Gilbert Simondon, Du Mode d'Existence des Objets Techniques, Paris (Aubier) 1958

[79] Amsterdam et al. (Elsevier) 2016, 6 (italics W. E.)

[80] See Mara Mills, On the Phone. Hearing Loss and Communication Engineering (forthcoming)

[81] See Timothy Barker / Maria Korolkova (eds.), Misunderstanding, London (Bloomsbury), forthcoming

algorithmic theory itself, trying to "convince mathematicians that randomness not only occurs in nonlienar dynamics and quantum machanics, but that it even happens in rather elementary branches of number theory"[83]. Very techno-logically, for both mathematics and science, in a nonlinear system "the change of the output is not proportional to the change of the input"[84].

CLOSE TO THE SIGNAL. "Radical" Media *Aisthesis*

"Radical" Media Archaeology

Differentiations within MA occur between variant approaches to technical artefacts and concepts: a) Historical / Cultural / Humanistic Media Archaeology; b) Economical and ecological / Anthropocenic Media Archaeology; c) Practiced-based / Artistic Media Archaeology, and d) Radical / Technical Media Archaeology.

Radical media archaeology (RMA), as it will be understood and declared here, analyses the essential message of techno-logical beings. It does not simply insist on the material and infrastructural *a priori* of communication and computational media for any kind of cultural content, as it has been emphasized by the first wave of Media Science (Kittler) in distinction against more discourse-oriented Cultural Studies in a kind of academic bifurcation of McLuhan's legacy. RMA rather researches techno-logical processes as epistemogenic knowledge formations in themselves, worth to be explored in an - a least momentary - suspense from their social, political, economic, or environmental functions.

The nature of such a research requires a clarification of what is specifically "radical" in radical media archaeology (RMA) in comparison with the notorious variety of current media-archaeological approaches. "Soft" and rather historically oriented media archaeology (MA) differs from "radically" non-historicist MA, as exemplified in practices of retrocomputing. Like computational science RMA, in its self-understanding as media *science* rather than *studies*, insists on the investigation of media matters beyond brute media materialism. Some misunderstandings and confusion of MA with archaeology as metaphor require further clarification (opening the techno-logical Black Box is no

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[82] Parisi / Portanova, referring to Kim Cascone, The Aesthetics of Failure. "Post-Digital" Tendencies in Contemporary Computer Music, in: Computer Music Journal 24 (2002)

[83] Gregory J. Chaitin, An Algrebraic Equation for the Halting Probability, in: Rolf Herken (ed.), The Universal Turing Machine. A Half-Century Survey [*1988], 2nd ed. Vienna / New York (Springer) 1994, 255-259 (258); see idem, Information, Randomness and Incompleteness, Singapore (World Scientific) 1987

[84] Wikipedia entry "Nonlinear System", https://en.wikipedia.org/wiki/Nonlinear_system, accessed April 1st, 2019

"excavation"), in favour of the media-epistemologically radicalized Foucauldean impulse - the archaeological *a priori*, and *l'archive*. The techno-logical grounding of Kantean "noumena" results in media-active signal archaeology.

In a second move, the scholarly concept of primarily body-related symbol operations ("cultural techniques") isradicalized into the hypothesis of an autonomous techno*lógos* that, in its techno-logical "call" (Heidegger), demands for media-archaeological uncovering. RMA comes close to Object-Oriented Ontology, while at the same time insisting on artefactual verification (Bogost's "alien phenomenology"). Special attention is paid by RMA to the identification, and derivation of media-theoretical consequences from the multiple frictions that occur in the implementations (or rather: primary entanglements) of the symbolical regime into (with) what may be coined the mateReal.

I: Towards a More Radical Archaeological Approach to Media Technology

The field of media archaeology, even if its definitions and methods are rather multiple than coherent, in terms of academic research, and artistic practice, still seems to be united in its concerns with media materiality from the past which deserves to be remembered, and experimented. This has been defined by Vivian Sobchack as scholarly or artistic ways of "re-presencing".

Archaeologically informed media artistic practice does not primarily focus upon so-called "dead media", but uncovers the material *arché*, and the technical *lógos*, in fact: the techno*lógos* of the media conditions insofar as this past (still) defines the present culture. To slightly paraphrase Foucault, such non-discursive conditions (which escape the historical arbitrariness of culture as discourse) constitute the elements of an archive which considers them "[...] not as documents (of a concealed meaning [...])", but as operative monuments: as rules of construction (engineering, algorithm). Such an analysis, "without assigning any origin and without the slightest gesturing towards the beginning of an *arché*", is "drawing on the ludic rights of etymology, something like an archaeology"[85].

The temporal mode of media-in-being can never be the past, but the present past in terms of Dan Graham's notorious video installation *Present - Continuous - Past(s)* from 1974, where the spectator, in the gallery, was confronted with his / her own image in an eight minute video tape time delay of extended presence.

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[85] Michel Foucault, Sur l'archéologie des sciences. Réponse au Cercle d'épistémologie, in: Cahiers pour l'Analyse, vol. 9 (1968), 9-40; quoted here from Daniel Defert / Françoise Ewald (eds.), Dits et écrits I (1954-1975), Paris (Gallimard) 2001, 724-759 736

As a form or description, media archaeography, different from media historiography, or history of technology, at least temporarily suspends technological artefacts and their media articulation (the techno*lógos*) from its discursive contextualization. With a focus on re-generating and re-storing time signals, media archaeology is concerned with the conditions under which the technological past, which extends to both "deep" and prospective media time (Huhtamo, Zielinski, Parikka), can "have 'presence' in the present".[86] But is this orientation, this insistence, and "rigorous attention to matter and machines"[87], more than a "post-digital" nostalgia?

Even if the focus is "on intersections between media archaeology and artistic practice"[88], the following arguments will not attempt a secondary scholarly reading of primary works of media-archaeologically informed art. According to the "Y" model, both academic analysis, and artistic investigation, radically root in the challenges of concrete material and / or logical artefacts and constellations, but their modes of tracing such "calls" of techno*lógos* (in Heideggerean terms) are categorically different - and in a positive understanding, even incommensurable. Artistic practice is a non-discursive media-theoretical inquiry, while academic media theory is an equally reflective, but independent form of investigation. Academic media archaeology should not be reduced to make verbally explicit the implicit media-artistic knowledge, and its technological individuations. Therefore, "radical" media archaeology is hereby proposed as an inspiration for both media-archaeological research, and artistic practice. Being inspired by media-archaeological research and related artistic practice, radical media archaeology dares to by-pass the allure of cultural historicism, in favour of a radically media-epistemic understanding of technologies.

What is "radical" in RMA?

There is a certain historicism, even romanticism, which has become associated with the discourse of media archaeology. The antiquarian approach refers to obsolete, even forgotten media from the past, and romanticism refers to the materiality of such relics, in opposition to the

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

[87] Michael Goddard, Opening up the black boxes: Media archaeology, 'anarchaeology' and media materiality, published 28 April 2014 in: New Media & Society, p. 13 http://nms.sagepub.com/content/early/2014/04/27/1461444814532193

[88] Electronic communication (18 November 2019) by Doron Galili, on the Stockholm University conference *Media Matter: Media Archaeological Research & Artistic Practice*, Filmhuset Stockholm, 27-29 November 2019

apparent immateriality of software-based contemporary digital culture. "Radical" media archaeology, on the other hand, is "archaeology" in the sense of a non-historical, and therefore as well non-narrative, approach to media as structures, as *l'archive* in the Foucaultean sense. Its archive is a present condition, which deserves transparency against the metaphors of interfaces and narratives. And it requires resistance against a melancholic reduction of media to matter. RMA rather shifts the attention to the encounters of the symbolic order with physical matter, which is the media-epistemological drama which unfold today. Archaeologically informed media art is a close analysis of technological hard- and software conditions, in order to demystify, e. g., the metaphysics of a so-called intelligence which emerges from artifical neural nets, and to demetaphorise the hermeneutics which is suggested by terms like "deep" machine learning, where the apparent depth is nothing but a topological configuration of signal-processing "layers" which are neither geological nor archaeological in the sense of an excavation, but mathematical models.

Against its prevalent associations with "dead media" research, "radical" media archaeology has a privileged affinity to techno-mathematics, with a critical focus on computing, especially in its current transitions from classical to unconventional architectures. For the critical analysis of computational media, the materialistic approach requires to be combined with a media-philological[89] microanalysis of code. This is what differentiates technical intelligence, in its literal sense, from previous machines.

The writing of the temporality of this media condition is not historiography, but archaeography - such as the literary "comment", is added to source code by programmers to explain their train of thought; the source code itself which drives computing, and its epistemic reflection, can be written in the same editor. Adrian Mackenzie calls such *in situ* analysis, in the field of machine learning, an "auto-archaeology"[90].

[Immanuel Kant's definition of the *apriori* of time and space as condition for human sensation has been, more positively, extended by Michel Foucault to the discursive *a priori*, before Kittler's materialist turn transformed it upside down into an analysis of the technical determination of culture. This approach, nowadays, already tends to be "historicised" within media studies itself. But any media analysis which loses contact with its technological ground will dissolve into a subset of more traditional hermeneutic humanities. A more "radical" media archaeology, on the contrary, is concerned with techno-epistemological insights which are derived immediately *from within* technology.]

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[89] On media philology as sister method of media archaeology, see Moritz Hiller, Medien, die auf Medien starren Eine philologische Spekulation [Media that stare at Media], in: idem / Höltgen 2019: 21-32

[90] Mackenzie 2017: xi

In that sense, conditional media archaeology as academic analysis, and artistic practice, is less about the historicity of technical artefacts from the past, not about their *arché* in the sense of temporal origins, but about their *arché* in the sense of governing principles, both material and logical, revealing the conditions of possibility of media phenomena in the enlightenment tradition of Immanuel Kant: opening the black box, instead of simply focusing on their interfacial in- and output relations.

[Against "Analogue Media" Romanticism: "Radical" Media Archaeology's Affinity to Mathematics]

Notwithstanding the adequacy of a material analysis for analogue technologies, "radical" media archaeology, as a method of media scientific research, is close to mathematics as well, if it claims to extend to computational media culture as well.

Media, when taken as physical channels of signal communication and as technical artefacts which are operated by symbolic codes and streaming data, require analysis which is different from textual hermeneutics, or works of art aesthetics. Media archaeological theory is a distanced way of looking at media objects: enumerative rather than narrative, descriptive rather than discursive, infra-structural rather than sociological, taking algorithms literally "into account".

A core target in the mathematical analysis and technical modelling of physical and biological processing is the signal *momentum* and direction. The calculation of vectors and trajectories is an alternative way of expressing what is the concentional "event", "(hi)story", or "evolution". Accordingly, the natural way of rendering Foucault's remarks on archaeology intelligible is to take the notion of enunciative function at its mathematical face value (like his affinity to serial, notably Barraqué's, music).[91] This is the context where Kittler proposes an explicitly "archaeological" research into the moment when counting with integers has been replaced by a system or real numbers.[92] The "digital" not only means the countable, but mechanically computable, and radical media archaeology is the material investigation of its mathematical mode.

"Radicalizing" Media Archaeology

Radical media archaeology as research method and media-scientific approach relates to techno-epistemological reasoning and insights from

[91] Martin Kusch, Discursive formations and possible worlds. A reconstruction of Foucault's archeology, in: Science Studies 1 / 1989, 17-25 (17)

[92] Friedrich A. Kittler, Die Maschinen und die Schuld, interview by Gerburg Treusch-Dieter in: Freitag No. 52/1, December 24, 1993

within technological events as techno-materially interiorized *lógos*. The social, cultural, political and historical impact *on* and *of* technologies is taken care of by Science and Technology Studies "or science, technology and society studies (both abbreviated STS)"[93]. On the other hand, the media archaeologial approach assumes that for an "alien phenomenology" (Ian Bogost), that is, for an understanding of media technologies from within, the analytic mind needs the freedom to be suspended from paying immediate or premature regard to the social, economic, ecologic or other kinds of impact. "Alien phenomenology" coincides with the media-archaeological premise in its focus on *operations* to describe how techno-logical units behave and interact among themselves[94], which is true techno-logical economy, before they become embedded in an external economy of media.

In its orientation at early versions of technologies, media archaeology is not meant in the historical, but literally pre-historical sense. Media archaeology is not interested in the historical past as such, but in different tempoRealities as an operator for the analytic understanding of technical things. In analogy to the physical concept of entropy, the time arrow is rather understood as a measure of tendency towards complexity. Media archaeology focuses on the archaic - not in terms of origins in the evolution of technical objects, but of principles which tend to be forgotten, or hidden, in the phenomenology of highly differentiated media, such as the central operations in a CPU, or GPU, in computing.

In radical media archaeology, the "radical" is not an avant-garde pretension, but rather understood in the structural, operative techno-mathematical sense of the "square root", as an analysis which stays close to the techno-logical complex which is both (electro-)physical *techné* and algorithmic *lógos*.

If the adverb "radical" is meant rather literally, it diagrammatically insists that "going to the ground" of media, in times of ubiquitous computing, means facing its techno-mathematical precondition. If technology is understood as (electro-)physically embedded materialization, or "objectification" of the mind (with Hegel), this at the same moment accepts the essential transsubstantiation which takes place when the symbolic order is implemented into the real. Radical media archaeology focuses on techno-epistemology rather than cultural research. While acknowledging discursive agencies that triggering new technological constellations, radical media archaeology short-cuts and by-passes the collective socio-historic context and its anecdotic individual narratives, in favour of an unimpended microscopy of technologies, in order to uncover

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93 https://en.wikipedia.org/wiki/Science_and_technology_studies, accessed October 16, 2018

94 Ian Bogost, Alien Phenomenology, or What It's Like to Be a Thing, Minneapolis / London (Univ. of Minnesota Press) 2012, 25

the sparks of knowledge which can be the better derived, the closer the analysis stays with the technological event.

[It is a specific quality of *media* epistemology that its analysis is firmly rooted within techno-mathematical constellations. Such technological configurations result on the one hand from condensed cultural, non-natural knowledge, while at the same time, as physically embedded knowledge, there is material self-referentiality and autopoiesis at work from which epistemic questions and insights either involuntarily arise or are being derived by conscious inquiry.]

A different kind of knowledge agency emerges when the technological is increasingly detached from the human, such as in "machine learning". In speech recognition, e. g., the former linguistic, "tele-phonic" approach of the Bell Labs has been replaced by the statistical one (the subsequent IBM approach), dealing with "big data" processing in terms of the mathematical theory of communication, such as Hidden Markov models, and the "noisy channel" premise which takes all kind of noisy acoustic signal input, articulated language or not, as equally human and non-human source of "information".[95] This logo-technical attitude has been prepared by the subsitution of the human operator in automatic telephone connection already for which the numerical approach to the machine (the dial phone and the Strowger electromechanical stepping switch) have been an archetypical instance.[96]

Previous cultural techniques not simply escalate into new technologies; the present situation rather enacts a new kind of techno-mathematical condition. Therefore, radical media archaeology short-cuts (with Occam's razor) the prehistories of technologies to its decisive moments, when the technological "spirit" (Hegel) becomes autonomous. Media theory therefore requires a different analytical attitude towards media: a non human-centered, rather ahermeneutic aesthetics of technological knowledge. A different vocabulary for analytic description is required, which borrows directly from communication engineering itself where it has been developed, but re-applies it different from its simply functional sense. It uncovers the epistemological beauty which is implied by terms like "logical gates", "delay line", or Norbert Wiener's "time of non-reality".

[As it has been defined by the curriculum at the University of Twente in the Netherlands, "[m]edium theory focuses on the medium characteristics itself [...] rather than on what it conveys or how information is received."[97] If "media" is understood as technologies in

[95] A central argument in Xiaochang Li's talk presented at the conference at NYU Berlin *Transsubstantiating Transmission: Walls become Ports become Channels*, Berlin, October 12 / 13, 2018

[96] Shari Wolk, An Undertaking: The Automation of a "girl-less, wait-less, and cuss-less" Telephone, talk presented at *Transsubstanting* conference, as cited above

[97] Entry "Medium theory", https://www.utwente.nl/en/bms/communication-theories/sorted-by-cluster/Mass%20Media/Medium_theory, accessed Oktober

themselves rather than being reduced to their function as agencies of human communication content, they extend to mathematical logics and non-historicist tempor(e)alities. The media-epistemic sensitivity is directed to the scenarios where, and when, the symbolic, the *lógos*, is implemented in the technically pre-conditioned mateReal, in order to become effectively operative in-the-world, i. e.: in time. This is the very material sense of Turing's term "effectively computable": gGiven enough paper (the inscription tape), writing matter (pencil), and finite time, humans still understand computation.[98]

II: "Radical" Media Archaeology and / as Artistic Research

Is there a belatedness of media art?

Technological media are not simply escalations of centuries-old cultural techniques. As noticed by McLuhan (referring to Samuel Butlers science fiction novel *Erewhon*), machines have started to emancipate in the meantime. Man lags behind; implicit media knowledge is already ahead of their current user practice. That is why the "content" of a new medium tends to be always simply the previous medium, before it is experimentally dis-covered by media-artistic avant-gardes in its technologically media-adequate aesthetics. This field is opened during its media-archaeological incubation phase, before this eqpoch is closded again by becoming a mass medium for consumer communication.

Günther Anders' book *Die Antiquiertheit des Menschen* carries the archaeological moment in its title: Humans are belated when compared with the possibilities and potentialities which are dormant within technological artefacts. In the age of technological reproduction, media themselves have become the agency of artistic production; the human artist is just the "shepard" of his technological objects (as expressed by Anders), such as Carsten Nicolai's media-artistic sonifications and visual insights into the nature of electricity by an oscilloscope. "Sonic" delay lines were developed for short-time storage in early digital computers (Turing's ACE) first, before this hybrid technology was re-discovered in Yun-Chul Kim's media art installation *Hello World!* (once presented at the Ars Electronica festival at Linz, having been developed at the Academy of Media Arts, Cologne). And Paul de Marinis' artistic re-invention of archaic forms of phonographic sonification has been anticipated by Édouard-Léon Scott de Martinville's "Phonautograph" in the 1860s - as if the archive of media-archaeological artefacts with its therein embedded implicit

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18, 2018, referring to the writings of Harold Innis, Marshall McLuhan, and Joshua Meyrowitz, No Sense of Place. The impact of electronic media on social behavior, New York (Oxford University Press) 1985

[98] See Finn 2017: 23 f.

knowledge is always already one step in advance of media-artistic anamnesis of such layers.[99]

[Radical media archaeology only occasionally "unearthes" obsolete media. It is rather about revealing, searching and identifying insights which can be derived from a close analysis of technologies from within. Resisting the temptations of cultural and anthropocentric metaphors, radical media archaeology analyses the technological condition, the techno-mathematical constellation and dynamics of what only then may become a discursive event. Investigative media-artistic archaeology detects, e. g., and re-sonifies, the presence of 13.56 MHz RFID tags used in plastic cards.[100]]

Media-Archaeological *Aisthesis* vs. Media-Artistic Aesthetics

In philosophy, the category of aesthetics pushes the explainability of works of art to its limit. Media archaeology rather reminds of the archaic Greek meaning of *aisthesis*, which refers to the actual channels of perception, be it in humans, or machines.[101] Critical media *aisthesis*, in consequence, stays close to the signal - either by its austere mathematical analysis (the "radical" archaeo*lógos*), or by making it media-phenomenologically accessible to human sense perception (in its ancient sense). Research-artistic representations of physical signal events, such as they emerge from within the Large Hadron Collider in Geneva, are creative ways to spot data patterns, and their stochastic trends, by data visualisation and sonification, thereby addressing them to human *aisthesis*. But when it comes to so-called media art, such as in the Synthgear blog which hosts a contest "to see who can make the best music out of sonified LHC data"[102], interface-oriented installations rarely lay bare and provide insight into their generative hard- and software techniques, which would be aarchaeology-prone artistic media criticism in the Foucaultian, rather than metaphorical, sense. Matt Parker's audiovisual installation *The Cloud is more than Air and Water* (2014) investigates "the mechanical nature and acoustic ecology of Data Centres and internet storage systems"[103] - even if it remains unclear to what degree the sonosphere is an actual sonification of the material, and

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[99] See Anthony Moore, Transactional Fluctuations 2. "Reflections on Sound", in: Siegfried Zielinski / Eckhard Frülus (eds), Variantology 4. On Deep Time Relations of Arts, Sciences and Technologies in the Arabic-Islamic World and Beyond, Cologne (Walther König) 2010, 289-304 (289 f.)

[100] http://shop.marcboon.com/snifferkit.pdf

[101] See Karlheinz Barck / Peter Gente / Heidi Paris / Stefan Richter (eds.), Aisthesis. Wahrnehmung heute oder Perspektiven einer anderen Ästhetik, Leipzig (Reclam) 1990

[102] http://www.boingboing.net/2011/02/14/making-music-with-th.html

[103] https://www.earthkeptwarm.com/the-cloud-is-more-than-air-and-water (accessed 2 December 2019)

energetic, base of metaphorical "cloud" computing.[104] The video stays metaphorical itself by not really opening the black box of such processing kernels. The aesthetic category of the sublime drastically differs from radical signal *aisthesis*.

[Fig.: Snapshot from the St. Elisabeth installation AIS^3, Berlin, from: http://www.imachination.net/ais3, accessed November 8, 2018]

Tim Otto Roth's *Astroparticle Immersive Synthesizer³* , e. g., has been installed from August to September 2018 at St. Elisabeth church, Berlin. The spatial installation of 444 luminiscent spherical loudspeakers, suspended from the ceiling, and LEDs, claimed to translate into an immersive audiovisual visitor experience the astrophysical measuring of cosmic Neutrino particles by a grid of more than 5000 electro-technical light sensors (so-called DOMs) sunk deeply into the ice of the Antarctic, at the IceCube Neutrino Observatory. While the sensors actually record the light flashes which are generated by occasional interactions of neutrinos with earth matter, the artist rearranged the data into a musical composition consisting of colour spectra and pitches. Do physical artefacts thereby become works of art?[105] Even if Roth's parameter mapping and data synthesizing, as an well-established tool of scientific sonification, let the measured physical events correspond to the phenomena observed by visitors of the Berlin installation, the degree of transposition, or even transformation has been applied by artistic manipulation remained unclear in the multimodal cloud of perception. *Anaesthesia* as a "state of controlled, temporary loss of sensation or awareness" is not only induced for medical, but as well as for media-artistic purposes.[106] What remained hidden, in the Berlin installation, is the chain of transformations that occur between the physical signals and their arbitrary artistic manipulation. While academic texts on media theory are obliged to keep their sources of ideas and information transparent by means of an inter-subjective discussion and explicits notes and bibliographical references, a work of media art remains fuzzy in its knowledge base. Roth's aesthetic Berlin presentation derives its authority from the scientific dispositive, but does not really reveal the degree of its indexical - or metaphorical - relation to it. What is known as *anaesthesis* in medical treatment (the temporal suspense of consciousness) here becomes media art aesthetics. It is the critical analytic focus on the precise momentum and location where techno*lógos* encounters physical matter, which separates radical media archaeological analysis from such rather arbitrary artistic data archaeology. The micro-media theatre enacts a drama which unfolds within technologies themselves, and differs from the external artistic choreography of media events.

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[104] As pointed out by Hugo Ljungbäck in his presentation "Clouds, Cables, and Compression: Making Sense of Data enters Through Matt Parker's Video Art" at the *Media Matter* conference, Stockholm, 29 November 2019

[105] The symposium at the end of the installation had the title *Physics & Art[efact]*, September 14 / 15, 2018

[106] https://en.wikipedia.org/wiki/Anesthesia, accessed 26 November 2019

Analogue technological signal transduction, and digital data processing, can be revealed as technological pre-condition of such media artistic installations indeed, which is sensors and A / D converters with their sample-and-hold mechanism. Practice-based, techno-investigative media artistic research opens this "black box" in terms of hard- and of software. "Radical" media archaeology goes back to the (square) roots of technology, not in the historical sense of origins, but in the structural sense of principles (ancient Greek *archai*): It traces the decisive moments in electronic circuitry (*techné*) and in source code (*lógos*), such as it is achieved in Ian Bogost's and Nick Montford's study *Racing the Beam. The Atari Video Computer System*[107] which identifies the time-critical cross-over between coding an archaic computer game (the symbolic, computational regime) and the scan line television for the visual output of animated objects and sprites (electro-physics). And research artist Ryan Maguire has developed techniques to recover sonic articulations, which usually get lost in data compression.[108] The MP3 standard is anthropocentrically oriented at human hearing and its limits of signal *aisthesis*. In contrast, the media archaeological ear is machine listening to the kinds of data garbage which falls victim to lossy compression algorithms. The field of analysis for such media-active archaeology is no past artefacts at all, but it is "radical" in its focus on the techno-mathematical operations of the computing machinery of today, and the signals, which otherwise occur unnoticed by cultural aesthetics.

Micro(-Artistic) Research: Declothing Media

In May 2009 the *Micro Research* lab in Berlin, curated by Shintaro Miyazaki, offered a workshop on the "Epistemology of electromagnetic waves". Other related workshops comprised subjects like the RFID sniffer which led to the practical construction of a simple analog electronic circuit to detect the presence of 13.56 MHz RFID tags which are commonly used in plastic cards in libraries or shops.[109] In media-archaeological terms, applied epistemology is technological micro-research, down to electronic and digital media forensics. Against the mysticism of unexplainable complexity (such as in recent Artificial Intelligence discourse), media-archaeology didactically seeks the archaic *arché*, reducing technological complexity to its fundamental, essential operations - be it core electronic circuitry, or core mathematical formula, which translate into source code for computing. In this way, media archaeology is an active examination and questioning of technology. "Open" soft- and hardware, in that context, can be understood literally: revealing its latent structures and "hidden layers" (such as in "deep" machine learning), in order to undermine the *dissimulatio artis* which is

[107] Boston, Mass. (M.I.T. Press), 2009

[108] See http://theghostinthemp3.com; accessed January 4, 2016

[109] See: http://shop.marcboon.com/snifferkit.pdf

the central trope of techno-rhetorics for media in order to be successful against human perception. Paranoia, in Boris Groys' sense[110], is a driving imaginary behind radically media-archaeological (formal and reductionist) *aesthesis*.

MEDIA ARCHAEOLOGY AS METHOD OF MEDIA (ART) RESEARCH

Media art as object and agency of media archaeology

As a method for the technical and scholarly analysis of media, media archaeology stays close to the essence of technology.[111]

At the same time, media archaeology, as a form of practice-based artistic research, is a genre of media aesthetics itself.[112] The experimental artistic, and the epistemological academic approach, branch into parallel, not necessarily complementary ways of media-archaeological investigation. They both start from the close reading of operative technical events and algorithmic agencies, such as the inductive coil to transmit wireless Morse code, or the role played by codecs in the transmission of audio or video files. Ryan Maguire actually performs a kind of acoustic media garbage archaeology by recollecting sonic articulations which became victim to lossy compression algorithms[113], while Jonathan Sterne reminds that a portable sonic medium like the MP3 player has its roots in psycho-acoustical research from a century years ago.[114] Media archaeology goes "back" to the *archai* (or the archive) of technical media, in its double sense of multiple "origins", and of still underlying "principles".

Media archaeology applies to technology-related arts in multiple ways. First of all, it is an aesthetics of analysis: the "cold gaze" and "cold ear" of distanced understanding - just as expressed in Dziga Vertov's film *The Man with the Camera*, where cinematography is not for human eyes only, but "kino-glaz". Media archaeological art treats digital sound and images not first of all musically or iconologically, but as a set of functions, which are calculable rather than narratable. While human cognition takes

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[110] Boris Groys, Unter Verdacht. Eine Phänomenologie der Medien, München (Hanser) 2000

[111] See Jussi Parikka, What is Media Archaeology?, Cambridge / Malden, MA (Polity Press) 2012

[112] See Erkki Huhtamo, Art in the Rear-View Mirror. The Media-Archaeological Tradition in Art, in: A Companion to Digital Art, ed. Christiane Paul (Wiley-Blackwell), 2016, chap. 3, 69-110; available online: https://www.oreilly.com/library/view/a-companion-to/9781118475201/c03.xhtml (accessed 2 December 2019)

[113] See http://theghostinthemp3.com; accessed January 4, 2016

[114] See Jonathan Sterne, Mp3. The Meaning of a Format, Duke University Press 2012

electronic sound and the (moving) technical image as given, and focuses on its *gestalt*, media archaeology analyses the time-critical coming-into-being of what humans (mis-)conceive iconically, and sonically. "Media art", in that context, is not simply another art form using technical devices as augmentation of aesthetic expression, but a genuine, technologically adequate, aesthetic form itself.

Marshall McLuhan, having been academically trained as literary scholar, in his seminal *Understanding Media* (1964), proposes a new kind of media philology, which does not interpretation of broadcast or "social" media content, but uncovers their underlying, technologically induced message. Techno-logical hermeneutics, when applied to works of media art, traces the implicit knowledge within embodied signal processing, its circuitry diagrams, and its "material semantics"[115]. Inductive experimentation with media as epistemogenic things has been an alternative to mass media use, such as Nam June Paik's Participation TV (1963): the magnetic distortions of the electronic TV image resulting from the cathode ray tube.

The terminological hybrid "media art" is itself indicative of the difference to traditional arts like painting, sculpture, or architecture. Having developed no *eigen*name, media art admits that it is primarily a function of its variable technological conditions. Media archaeology therefore closely examines the technical core of media works of art as they actually operate, while resisting its reduction to aesthetic interpretation. Then it becomes an "archivology", deeply obliged to archival evidence and technological precision (circuit diagrams and code as source of evidence). Finally, it results in an art forms which display aspects of media in its archaic basics, revealing, e. g., the otherwise intangible processes, which are hidden within microprocessors in contemporary computing.

Culture, society and communication studies such as Bruno Latour's Actor-Network Theory acknowledge the nonhuman agencies but still privilege their discursive dependencies. They focus on the semiotic rather than signal-based approaches to technologies, while "Software studies"[116] and "platform studies"[117], and a refreshed materialist ("forensic") approach[118], look at the actual technological drama: the implementation of the symbolic order into the physical real as the core media archaeological scene.

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[115] Monika Wagner, Das Material der Kunst. Eine andere Geschichte der Moderne, Munich (Beck) 2001

[116] Matthew Fuller (ed.), Software Studies. A Lexicon, Cambridge, Mass. / London (MIT Press) 2008

[117] Ian Bogost / Nick Montford, Racing the Beam. The Atari Video Computer System, Boston, Mass. (MIT Press), 2009

[118] Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (MIT Press) 2008

Media archaeology as "dead media" research

At first glance, the research field of media archaeology looks like being devoted to the aberrant, curious, or forgotten paths in the global history of technology. There is a branch of media artistic research which focuses on "dead media" for their creative reappropriation indeed. The archetypal *emplotment* of media-archaeological artistic research, in its preference of ancient artifacts, is driven by the desire to revive them.[119]

Since Bruce Sterling first used the term "dead media" in a speech delivered at a symposium on Electronic Art in 1995 to address lost, marginalized or obsolete media[120], the resulting project ("part archive, part nostalgia, part requiem"[121]) itself almost disappeared and "became obsolete" (ibid.). The thematic mailing list itself died. Even if the Dead Media Project still holds a URL and has a ‘holding’ Web site in place with (a) few functional links, hypertextual links like the "Dead Media List" for research and comments are disconnected: "a 404 Not Found error was encountered while trying to use an ErrorDocument to handle the request."[122]

Radical Media Archaeology

While the majority of media archaeological research deals with forgotten or "dead" media (Bruce Sterling), "radical" media archaeology (in the sense of the square root) rather opens the black boxes of techno-mathematical operations in present media. Radical media archaeology avoids the attractive and seductive, but tranquillizing metaphor of resurrecting past technologies. Different to the materialistic "dead media" approach, in its more "radical" version (in the sense of the mathematical square root where "√" is the radical sign, or root symbol), media archaeology traces the technical "roots" and investigates codes and circuitry, of which the user interfaces are just a phenomenal

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[119] On the Romantic "re-presencing" gesture of media archaeology, see Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds.), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333

[120] Bruce Sterling, The life and death of media, speech at Sixth International Symposium on Electronic Art ISEA ’95, Montreal, September 19, 1995

[121] Tara Brabazon, Dead media: Obsolescence and redundancy in media history, in: First Monday, vol. 18, no. 7 (July 2013), at http://firstmonday.org/ojs/index.php/fm/article/view/4466/3701; accessed November 20, 2015

[122] http://www.deadmedia.org/mailman/listinfo/deadmedia (accessed March 30, 2019)

function. In its focus on the operative momentum of media (technológos in being), radical media archaeology is a decisively non-historicizing approach.

Archaic "radio" research (for example)

In media archaeological analysis and aesthetics, the complexity of contemporary media is systematically reduced to its archaic core elements (ancient Greek *archai*) - less in terms of historic origins, but rather to reveal the principles (or *topoi*[123]) which insist or recur through generations of media. Heinrich Hertz' spark gap oscillator and resonator, installed in the 1886 in a lecture room of Karlsruhe Technical High School, involuntarily resulted in the "first" radio transmission *avant la lettre* - an ongoing beginning indeed, an epoque which does not end with digital mobile media but rather reaches its climax. Any media-archaeological reenactment of Hertz' proto-radio setting in a museum or art gallery context is authentic media theatre: The media operation is radically present and not reduced to a mere historical quotation. Challenges to conventional (mostly linear) concepts of historiography of technology are a core argument in time-critical media archaeology. Raviv Ganchrow practices such truly medi*um*-scientific artistic radio research. In his work-in-progress *Spark-gap* (in collaboration with Deutschlandradio Kultur) at Künstlerhaus Bethanien open studios, Berlin, he patched a circuit where radio signals the domestication of lighting. Such "implicit radio" is real media-archaeological radio event. The reenactment of early radio experimentation is more than just a role play; it actually reproduces something which is still there: materials that stay, techniques that propagate.[124]

Media-artistic research as method

Experimentation with technological media reveals knowledge of a secondary nature, where measuring media like the oscilloscope (for analogue wave forms) or the Logic Analyzer (for "digital" pulses) become the crucial observers themselves. The highly integrated microchip is an artificial configuration of natural elements based on cultural knowledge, an encounter of *lógos* and matter. Electro-physical laws are at work here which are rather independent from the arbitrariness of cultural discourse. The media event can not be reduced to discursive effects. There is always the chance for a physical or logical "veto" in terms of electronics

[123] See Erkki Huhtamo, From Kaleidoscopomaniac to Cyberned: Notes Toward an Archeology of Media, in: Timothy Druckrey (ed.), Eletronic Culture. Technology and Visual Representation, New York (Aperture) 1996, 296-303

[124] As expressed in his talk on February 6, 2019 *Spark-gap. Field notes from circuitries of the Actual*, at Humboldt University Berlin, Institute of Musicology and Media Studies

and algorithms. Manifestations of media art display a conceptual awareness of such material frictions and informational disruptions within so-called information society.

Media archaeology is not dealing with utopean promises or phantasmatic worries of technological progress, but rather discovers what has been already there, especially if this is more or less hidden or subliminal today. Different from the visions which have dominated the first generation of media art, media archaeological re/search rather reminds of the literal meaning of the Latin term *inventio*: Every invention is as well a re-invention, discovering the "always-already-there".

Media artist Jan-Peter Sonntag, in a conscious aesthetic reference to Rembrandt's depiction of the *theatrum anatomicum*, has directed a qualified anatomy of late Friedrich Kittler's self-built electronic music synthesizer: no destruction of the artefact but its un-covering, a literal de/construction, un-earthing knowledge about the machine and its author at the same time - material hermeneutics.

The gallery room Sur la Montagne in Berlin has been transformed into a viable three-dimensional camera obscura by Christian Schliebs (*SlaMera Obscura*, July 2011). While the epistemological awareness of the camera obscura (Platon's "cave" metaphor) is a concern for media studies, the actual art installation provides for insights which are not primarily based on academic discourse and the printed text but on the physical experience - a true media theatre. The artistic installation implicitly served as a critical question addressed to the generation of Youtube-related digital natives. The project report, though, still has the classical form of the textual argument. Academic media theory brings out the epistemological surplus which is dormant within media technologies and media arts. Aesthetic knowledge needs to become explicit in order to become reflective, and this primarily takes place in the medium of verbal text - the classical cultural technology as practiced in universities. Different from that logocentristic explication of knowledge, there is implicit knowledge which stays in a kind of archaeological latency within the media. Artistic practice can evoke this implicit *epistemé* to create affective forms of *insight*. But both academics and artists must be "tuned" in the right way (frequencies) to be able to "resonante" with that knowledge.

Such analytic methods are not restricted to academic or artistic research, but are performed by programmed machines themselves. An example is the Mandelbrot fractals which were accelerated by computing and all of the sudden showed the *Gestalt* iterations on the computer screen. Such figures could hardly have been discovered by endless lines of calculation in symbols on paper by human mathematicians.

Another case is the *Detectors*, developed by Shintaro Miyazaki and Martin Howse to sonify the hidden electromagnetic rhythms which media-environmentally surround everyday electronic devices, thus revealing the almost musical, essentially "algorhythmic"[125] character of internal microprocessor activity. In case of sound, sonagraphic software is able to analyze acoustic articulation in ways which symbolic music notation (the score) could never do.

Media-archaeological artistic experimentation

[In the tradition of Lessing's *Laokoon* (1766), Rudolf Arnheim's "Towards a New Laocoon" and Clement Greenberg[126], the semiotics in the Fine Arts, in Literature, in Sound Film and in Modernist Painting are defined as a function of their medium specificity.[127] Distribution in space and on screen privileges the synchronous aspects of an artistic articulation, while narrative unfolding in time privileges action. As emphasized by McLuhan (1964), the real medium message of Cubism in chronophotography, and with sound film, the purity of a "medium specific" aesthetics has become hybrid itself. (Hausken 2013: 34, Introduction 29-50).]

McLuhan, in the first chapter of *Understanding Media*, refers to Clement Greenberg's analysis that modernist painting itself has exibited the grounding materiality of the rectangular canvas as its principal message.[128] Invasive media archaeology is no "excavation" but an evidencing of such grounds in the technological field, close to the signal. In his 1974 piece *Exercice IV de l'abécédaire télévisuel*, Swiss video artist Jean Otth manipulated the line deflection electronics of a TV set in order to create a simple horizontal line on the screen pulsed by the line transfer rhythm. For the reconstruction of this video installation in Kunstmuseum Luzern (2008)[129], a measuring test of the signal flow on the oscilloscope proves that this has been a conscious manipulation and not just a defect of the apparatus.[130]

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[125] Shintaro Miyazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, in: Computational Culture, Issue 2 / 2012, http://computationalculture.net

[126] Clement Greenberg, Towards a New Laocoon, in: Partisan Review Bd. VII, Nr. 4 (1940), 296-310

[127] See Liv Hausken (ed.), Thinking Media Aesthetics. Media Studies, Film Studies and the Arts, Berlin (Peter Lang) 2013

[128] See Clement Greenberg, Towards a New Laocoon, in: Partisan Review, vol. VII, no. 4 (1940), 296-310

[129] Catalogue: Irene Schubiger (ed.), Schweizer Videokunst der 1970er und 1980er Jahre. Eine Rekonstruktion, Zürich (ringier Verlag) 2009, 92

[130] Johannes Gfeller, Anmerkungen zum restauratorischen Hintergrund der Ausstellung, in: Schubiger (ed.) 2009, 124-135 (125, figs. A and B)

The Elementary Approach: Image Analysis down to the Pixel

Gregory Barsamian's media art installation *The Scream* (1988), presented in the exhibition *Vom Funken zum Pixel* [131], has been inspired by early animation techniques previous to the intention of cinematography proper (such as the Zoetrope or the Phenakistoskope) and at the same time in its material installation is a reminder of the difference to pixel-based moving images.

Another example is the long-time ("Bergsonean") photographic exposure of theatre performances by Aljoscha Begrich, Lucas Fester and Jo Preußler, exhibited under the title of *Flüchtige Totale* in the Deutsches Theater, Berlin, April 2005.

In her installation *Blow up TV*, media artist Angela Bulloch quotes a key visual sequence from Michelangelo Antonioni's film *Blow Up* (1966) where a photographer's camera, hiding behind a tree in a parc, involuntarily registers a murder. But in trying to identify the spot after the photochemical development, the closer the camera looks, the less is the apparent murder an evidence. Bulloch extends this process of identification by yet another magnification, enlarging the digital scan of this scene in great blocks of its single pixels.

[Fig.]

The image *implodes* by slowing down the cinematographic motion to one digit per second (thus undermining the copyright which is based on the recognizability of the motive for the spectator), and on the other hand the original image *explodes* within a sequential modular system of purpose-build so-called *pixel boxes*, where one pixel is represented in a 50 x 50 cm monitor which are attached to complex RGB lighting systems which can be generated and programmed with any digital information. The pixel modules, developed by Angela Bulloch and Holger Friese, indicate that artistic media archaeology requires high-technical skills.

As a disillusion of the technical image betrayal of the human eye, the scanner-gaze of the computer is "looking" at a different kind of evidence, in media-active archaeology. The pixel modules point at the fact that digital images are hyper-indexically composed by pure information, as opposed to the referential image (photo-chemical photography) which still suggest a pre-discursive real.

The pixel is the smallest (even unconceivable) picture element. It is literally *making sense* in an iconic way only when appearing within a

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[131] October 2007 until January 2008, Martin-Gropius-Bau Berlin, curated by Richard Catelli

group. When the square of light made by a single pixel is 50 x 50 cm, the distance between the viewer and the group of pixels must be large in order to discern the image. The closer the media-archaeological eye is looking at such elements, the more distant the "image" looks back. In addition to spatial distance, such a media-archaeological aesthetics reveals a temporal extension. In order to perceive a "movie" (moving images composed here by pixels), the momentary glance does not reveal the temporality. It takes time (like David Gordon's *24 Hours psycho*) to see a movie this way.

Artistic media archaeology of the electronic image

Media archaeological aesthetics of knowledge is not driven by nostalgia, but is rather enchanted by the techno-epistemic momentum itself, like the occurrence of electro-magnetic waves. It is the wonder of the successfully generated, transmittted, synchronized and received electronic TV image which has been investigated by Nam June Paik's installation *Participation TV*. Such aesthetics of techno-knowledge is not simply affective; what articulates itself here is accumulated cultural knowledge of material techniques and logical reasoning. In his Exposition of Music – Electronic Television[132], Paik demonstrated the electro-magnetic nature of the transmitted TV "picture" by magnetic modulation; user-generated interference here results in "participative" media aesthetics. The figures of the electronic image are exposed as a function of the technological raster. The difference between video art and commercial television is not its electronic aspects but those in content.[133] Interference is not experienced as bad luck here, but as aesthetic stroke of luck.

Eric Siegel reminded of the electro-magnetic fields as the essence of the video "image" by moving a magnet across the electronic TV tube, distorting the image without damaging the set.[134] In the technical sense, such disturbances actually disclose the physical nature of the transmission channel as core "medium" criterion, and is therefore part of techno*lógos* itself. The signal-to-noise ratio (S/N), as defined in communication engineering, refers to the proportion of desired to undesired signals - which still might become aesthetic "information". Media artistic archaeology is about such revelations in the very precise engineering sense. Noise is any unwanted signal present in the total signal[135] but can become part of the media-artistic intention itself. The

[132] In the gallery Parnaß, Wuppertal, from March 11th – 20th in 1963
[133] Wulf Herzogenrath, Videokunst. Ein neues Medium - aber kein neuer Stil, in: idem. (ed.), Videokunst in Deutschland 1963-1982, Stuttgart 1983, 1-27 (13)
[134] On Shamberg & Raindance Corporation, Guerilla Television, 1971, see Ina Blom, The Autobiography of Video. The Life and Times of a Memory Technology, Berlin (Sternberg Press) 2016
[135] According to http://experimentaltvcenter.org/video-terms

humming of the electronic video image is a reminder of its high frequency scan line feature. Viola's definition of the electronic image as "sound" of one-line scanning[136] unintentionally resulted from a laboratory signal event, while his media-artistic curiosity has been prepared to interpret such contingencies as "epistemic thing"[137]. His videotape *Information* (1974, colour, sound, 30') has resulted from a technical mistake made while working in the studio: "an aberrant electronic nonsignal passing through the video switcher in a normal color TV studio, and being retrieved at various points along its path. [...] When the record button was pressed, the machine tried to record itself. The resulting electronic perturbations affected everything else in the studio: ... there was sound where there was no audio connected ... After this error was discovered and traced back, it became possible to sit at the switcher as if it were a musical instrument and learn to 'play' this nonsignal. Once the basic parameters were understood, a second videotape recorder was used to record the result. *Information* is that tape."[138] Communication engineering defines information as a measure information of uncertainty indeed (so-called Shannon entropy[139]).

Sonic Media Archaeology

Media archaeological (artistic) research, such as Paul deMarini's installations of the Edison phonographic principle[140], even if at first glance dealing with discoveries of past technologies, is an exercise in resisting to the metaphorical "unearthing" of "dead" media. The cultural phantasm of the undead is rather redefined in technical terms.[141]

Sound recording media artefacts from the past not only preserve the memory of cultural semantics but past *technical* knowledge as well. There is kind of a frozen media knowledge embodied in engineering, waiting to be un-revealed by media-archaeological consciousness.

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[136] Bill Viola, The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (eds.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54

[137] Hans-Jörg Rheinberger, Toward a History of Epistemic Things. Synthesizing Proteins in the Test Tube, Stanford (Stanford UP) 1997

[138] From: Bill Viola. Installations and Videotapes, ed. Barbara London, New York (The Museum of Modern Art) 1987, 24

[139] See Claude E. Shannon / Warren Weaver, The Mathematical Theory of Communication, Urbana, Illinois (Univ. of Illinois Press) 1949], München / Wien (Oldenbourg) 1976

[140] See Paul DeMarinis, Buried in Noise, ed. by Ingrid Beirer et al., Berlin (Kehrer) 2010

[141] See Garnet Hertz, A collection of many problems, Los Angeles (Telharmonium Press) 2009, at http://www.conceptlab.com/problems, and idem, Methodologies of Reuse in the Media Arts: Exploring Black Boxes, Tectics and Archaeologies (2010), *online* http://escholarship.org/uc/item/5r8842r6

Phonography did not just provide historical research with a new kind of source material; it rather articulates a new, almost ahistorical form of tempor(e)ality on the physical level of the acoustic signal.

Media archaeology deals with "modern", that is: technologically mediated hearing in the sense that it is media devices as active "archaeologists" which reveal previous sounds of the past. In one of his media artistic projects, Paul deMarinis translates "illustrations and engravings of sound vibrations from old physics and acoustics texts, many of them predating the invention of the phonograph"[142] *back* into sound files. A "technical note" reveals the media-archaeological procedure: "The traces were scanned on a flatbed scanner, extracted and isolated by a number of processes in Photoshop, then transformed into audio files via a custom patcher in Max/MSP. The sounds were then presented [...] as aiff files played back on a conventional CD player."[143]

Electronically Radicalising "Time-Based" Art

Media analysis is basically the experimentation of temporal figures; the chrono-photographical *dispositive* of Eadweard Muybridge was created to answer the question if horses in the course of galopping at one moment lift all four legs above ground (too fast to be noticed by human eyes, such as the painterly gaze). The laboratory setting constructed by Ernst Mach and Peter Salcher to measure the speed of a bullet by electro-photographical short-circuits made use of the electric spark as subject and object of photography itself. In both cases, the camera time-critically recognizes events which the human eye does not see at all. In the media installation *The Insivible Shapes of Things Past* (1995-2007) by Joachim Sauter and Dirk Lüsebrink (Art + Com, Berlin), e. g., the time-based sequence of cinematic frames is spatialized into sculptures of movement that make *The Shape of Time* (George Kubler) actually tangible.

Narrative time, as it is familiar from literature, has been replaced by temporal delay in the technical circuit between camera and monitor, such as in Bill Viola's video installation *Slowly turning Narrative* (1992). In Gary Hill's video installation *Inasmuch as it is Always Already Taking Place* (1990), video tapes whose time code (numbers) remains visible, are being rewound again and again. In Viola's video installation *Heaven and Earth* (1992), two monitors mirror each other, one with a baby's face mirroring the other with a old, dying woman's face. While this confrontation of ageing has been a symbolic one, Dan Graham's video-installation *Present - Continuous - Past(s)*, in 1974, delayed the electronic image of a human visitor's presence on video monitors in the gallery by an eight minute loop, as a new kind of temporal interfacing.

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[142] DeMarinis 2010: 247
[143] DeMarinis 2010: 252

Algorithmic media aesthetics

Media artistic research is no longer restricted to author-centered, individual creation. It is electronic circuitry and algorithms which have eliminated the subjective approach to art, and the "artist" is rather becoming reprogrammed - such as in Manfred Mohr's Cubic Limits series from 1973 onwards[144], and Max Bense's Stuttgart school of "generative aesthetics" of computational formalism (Frieder Nake, Georg Nees). If the "new" in New Media Art (which separates it from so-called "analog" techniques) refers to digital technologies, a specific affinity between radical, that is: techno-mathematical media archaeology, and computing, becomes apparent. While the media-archaeological approach derives aesthetic value from the nonhuman, rather techno-logical behaviour of the machine, the media-phenomenological approach tries to "humanize" the machine. Harold Cohen's Aaron program created machine paintings analogous to human cognition in early Artificial Intelligence where "the aim is to model human art-making behavior, rather than merely to use the machine as a tool"[145].

Analytic media art, by its very techno-logical coexistence of electronic materiality, and logical circuitry a. k. a. software, can be defined as a critical symptomatology of media culture by aesthetic means. In its predominantly direct appeal to the human senses, media archaeological artistic research does not simply concentrate on the figurative phenomena, but reveals the ground (the analog electromagnetic field, and the digital matrix). Media archaeological analysis first of all addresses the (infra-)structural, material level of media practice, as well as its structuring, time-based and time-critical actual operations (processual); that is: the governing techno-logical laws, such as Internet protocols or the von Neumann-architecture of digital computers, and its actual being-in-time.

Computational media archaeology as artistic demon(stration)

Artistic media archaeology is not necessarily about "dead media" from the past, but rather their radical re-presencing. Ben Fry's *Deconstructulator* - created as part of his Visually Deconstructing Code series shown within the Linz Ars Electronica festival CODE exhibition in

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[144] See Grant Taylor, The Soulless Usurper, in: Hannah B. Higgins / Douglas Kahn (eds.), Mainframe Experimentalism: Early Computing and the Foundations of the Digital Arts, Berkeley, Cal. (University of California Press) 2012

[145] Harold Cohen, Parallel to Perception: Some Notes on the Problem of Machine-Generated Art, in: Computer Studies IV - 3/4 (1973), 1-10 (abstract); see Pamela McCorduck, Aaron's Code: Meta-Art, Artificial Intelligence, and the Work of Harold Cohen, New York (Freeman) 1991

2003 - "is a deconstructed Nintendo emulator that shows how sprites and sprite memory are handled while a game is being played. The intent is to show insight for how software and hardware work, given the relatively simple example of a minimal architecture from an old game console system."[146] Fry's *Deconstructulator* modified source code of the NESCafe emulator written by David de Niese which Fry hacked up literally "a bit" (bit-wise) "to dynamically show aspects of how the machine works" (ibid.).

Media-artistic temporalities and the art of dis-continuing media from the past

In both artistic and academic media archaeology the temporal dimensions and recursions of technologies has been a growing subject.

The media-artistic impulse is not just a passive product of the current media sphere, but actively assists in dis-continuing former practices which hinders the present to think the new ones. Programming video streams is different from recording electronic images; algorithmic art is different from the direct manipulation of matter, and new media temporalities create a chronosphere of its own, not exclusively subjected to the contextual time of discourse in which they are embedded. Video artists like Paik have articulated media temporality and materiality, transcending simply time-based performances (like theatre) towards an archaeology of time-critical processes, i. e. media practices where micro-temporal action is decisive for the success of the event at all.

The "beginning" (the *arché*) in media *archae*ology is not primarily about origins in the past, but about principles, the rules that govern media operativity both as hard- and as software commandment[147]: the execution of orders, procedures, patterns, and just-in-time routines. Media archaeology educationally reduces complex techno-mathematics to the essentials. Therefore its focus is on the Assembly programming language which stays time-critically close to the machine. Here, mathematical operations become materially transparent; Assembly thereby provides a sense for actual computing.

Media archaeology not only sharpens the awareness of microtemporal, but as well macrotemporal, even "deeply" geological dimensions in current media practices, with regards to the rare earths used in microelectronic production and resulting in "anthropocenic" waste.[148] Such temporalities are not necessarily of a historical kind - which is a

[146] http://benfry.com/deconstructulator (last up-dated: November 2003; accessed April 21, 2016)

[147] As defined in Jacques Derrida, Mal d'Archive, Paris 1995

[148] Jussi Parikka, A Geology of Media, Minneapolis / London (University of Minnesota Press) 2015

message of artistic critique of the concept of media history. In spite of its metaphorical associations, media archaeology is not primarily about digging into the past but about mathematical roots of digital media operations. In Lynn Hershman-Leeson's film *Conceiving Ada*; by coding the computer a programmer in the present time gets in touch with the past - the "ghost" of Ada Lovelace, the mathematical mind behind Charles Babbage's mechanical proto-computers in early 19th century. Once the narrative romantic overtones are set apart, it is logical reasoning implemented into (in)formative matter which allows for a media-archaeological short-circuiting of "historical" distance, in favour of algorithmic tempor(e)alities.

Contemporary digital media sometimes root in cultural techniques as ancient as the alphabet, or the differential calculus which hsa been developed by Leibniz in the age of the baroque. Still, media archaeology can not be reduced to contextual information about past media, but creates situations where one gets into direct contact with media in its radical operability and temporality. Technologies in this sense are time-machines. Media-archaeological research is branded not by a historian's interpretative interest but by sharing the techno-mathematical situation in its non-historical presentness. This applies to archives and machines as well: "Their functioning operations are the media archaeological moment that is at its core un-historical."[149]

Media-Archaeological Micropolitics

The only way to understand digital media, or technical media more generally, is to understand how it puts physics and mathematics into operation, makes formulas into commands, and how engineering creates so many functions that are still mistaken as human. Media archaeological micro-research is not simply about hardware but also "focuses on the time-critical processes which engineer our lives" (Parikka ibid.).

Media archaeological arts are actually less about artists working with historical technologies than about hardware hacking, and open software experimentation. "Circuit bending" is a method of operative analysis in media arts, a creative misuse of (low-currency) electronic devices by short-circuiting[150], often used in the acoustic field to create new kinds of sound by means of a "jumper" cabel which connects two points in the circuit in a way not intended by the engineers.[151] Lev Thermen applied this already when applying radio technology to create his "Theremin vox"

[149] Jussi Parikka, Cartographies of Media Archaeology, entry November 22, 2009, http://mediacartographies.blogspot.com

[150] See Garnet Hertz / Jussi Parikka, Appendix: Zombie Media: Circuit Bending Media Archaeology into an Art Method, in: Jussi Parikka, A Geology of Media, Minneapolis (University of Minnesota Press) 2015, 141-153

[151] See the compilation CD *Noise and Toys* vol. 1 (2006)

which invites for the active interference of the body as a capacitor (hand gestures) into an electro-magnetically oscillating field. In its computational equivalent ("hacking"), the manual "tinkering" of electronic circuitry, though, is replaced by "algorithmic thinking".

Media archaeology is interested in the micro-political conditions in which the technical commands, executions and operations take place, the contexts which are hidden in the physical and logical layers of media machines and need to be articulated radically. Somewhat close to the object-oriented ontology approach, media archaeology understands media with the "ears" of the machine.[152] Media archaeology sees its special responsibility to open technological black boxes, revealing the computational heart beat behind the visual interface. Microprocessors process and transmit data as signals, of which most human users are unaware, even without their permission. In that sense, media archaeological research is not only performed by engineers, artists, and academics, but foremost by machines themselves.

"DIGITAL DISH": Questions concerning "Radical" Media Archaeology[153]

Bobnic: "[...] to start with the following summary: only when operative, media are present, they are in time" - and only then, they are in their "media" existence. "[O]therwise, they are history. From this follows the importance of time in the understanding of media and the way technical media disrupt history, which is the prevailing temporality based on writing." In fact, historiography, as narrative writing, is symbolical "time", but not enacting a physical tempoReality.

Computing means counting by numbers instead of story telling, and the stochastic *lógos* of Markov chains of zero order, in information aesthetics,

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[152] See Morten Riis, Where are the Ears of the Machine? Towards a sounding micro-temporal object-oriented ontology, in: Journal of Sonic Studies, portal issue 10 [October 2015], https://www.researchcatalogue.net/view/219290/219291

[153] Suggestions, and questions for discussion, by cand. Ph.D. Robert Bobnic, University of Ljubljana, June 16, 2021, following the online-presentations by W. E., Against the "Dead Media" metaphor. "Objectified" and Processual Media Analysis in the Media-Archaeological Fundus, and "Radical" Media Archaeology as its Research Method, from MAF, Humboldt University, Berlin (coupled with a contribution by Stefan Höltgen, Signals & Noises. Scenes from a retro-computing hacker space, from the Signal Laboratory of Humboldt University) for *Digital Dish* series, organized by Ljudmila Art And Science Laboratory (a successor to the Ljudmila - Ljubljana Digital Media Lab of 1994, a program of the Open Society Institute Slovenia), and Projekt Atol Institute (Ljubljana), 17th of June, 2021

even ignores knowledge of the past to predict the immediate future. Just like the cinematographical apparatus, computation is challenging the linear "time axis", as digital anachronism. Time-discrete computing as articulation of techno*lógos* is listening to computational tempoRealities. In the momentary, "chronophotographic" processuality of actual computing, *lógos* comes into its technical being.

Bobnic: "Vilém Flusser has a book, entitled with a question *Does Writing Have a Future?* We can turn this question into the question Does History Have a Future? If the future of the history is digital – if nothing else because of the entropy of material – then the history will become digital archive, which is based on different media logic." According to Flusser, with computational media, culture already has been entering its *post-historic* era; different from symbolical "chrono-poetics", con"temporary" media culture is organized according to its technical "chrono-logic". It has been Alan Turing, who in his lecture on the "state of the art", in 1947 advised for the digital computer: "treat time as discrete".[154]

With coded matereality, physical matter which is subject to "entropy" transforms into an existence of "two bodies" (in allusion to Ernst H. Kantorowicz' seminal study on *The King's two Bodies*): one being mortal, vs. the "eternal" time of coded information.

Bobnic: "[I]n recent years you have dealt extensively with the notion of *sonicity*, with which you analyze technicity of time – the understanding of time with technology." The neologism "sonicity" has been termed to define *implicit* sound which is not acoustically present to the human ear, but occurs in the form of sound-like oscillations, and signal wave forms, like alternating electric current from the socket with a frequency of 50 Hz. Within digital, algorithm-driven media, another kind of implicit sonicity occurs: "algrhythmics" (Miyazaki)[155].

Günther Stern (*alias* Anders), in his habilitation thesis *The Musical Situation* (*Die musikalische Situation*) from around 1930, emphasized that a musical event, even if the score or recording is from the past, always occurs in the present. This is a direct analogy to pressual media.

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[154] Alan Turing, The State of the Art. Lecture to the London Mathematical Society on 20th February 1947, in: B. E. Carpenter / R. W. Doran (eds.), A. M. Turing's ACE Report of 1946 and Other Papers, Cambridge, Mass., et al. (The Massachusetts Institute of Technology) 1986 [Vol. 10 in the Charles Babbage Institute Reprint Series for the History of Computing], 106-124

[155] See Shintaro Miyazaki, Algorhythmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012; http://computationalculture.net/algorhythmics-understanding-micro-temporality-in-computational-cultures

Bobnic: "[I]s the notion of sonicity still pertinent for the understanding of media?"

A significant part of technical artefacts in the MAF are actually *sonic* media. Even physically, the MAF is the architectural linkage between the otherwise separtely located two departments of the Institute of Musicology and Media Science. Even our "house ghost" philosopher G. W. F. Hegel had a sense for the temporality of phonic articulation: The tone already disappears when it is acticulated. And in conceptual and analytic terms, the temporality of (time-)signals has first been experienced, in European culture, in music and music theory.

Bobnic: "You are stating that this is the condition of ahistorical temporality obtained from the analysis of the way media machines process time with their recording, storage, playback, processing, and production of signal and information. In short: if we want to understand time, we must analyze the notion of frequency or clocked time in the computer's processual unit. In some of your recent articles and lectures, you are stating that digital computing is 'counting rather than timing' and that 'time' is not plausible for contemporary digital condition."

At least, this refers to narrative (i. e. symbolic) time.[156] Computation replaces linear time by non-linear jumps. Recounting (German *Erzählung*) becomes counting (*Zählung*) - does this word play work in Slovenian language as well?

Bobnic: "Regarding the understanding of digital technology, the critical mode is largely based on questions such as alienation of the future in predictive algorithms, or the alienation of knowledge in the so-called black box. Despite a large media-archaeological corpus on these questions, *radical* media archaeology stands on its own ground, dealing mainly with the knowledge of material operability of technical media"

- and its mathematical edge: "radical" in the sense of the square root symbol "√", and "grounding" technical analysis in the engineering sense.

Bobnic: "Is there a need to incorporate media archaeology in other sociotechnical analyses of digital and technological culture, or the other way round?"

The media-archaeological perspective is the other way round indeed. Different from, e. g., Science and Technology Studies, it radically suspends technological analysis from its premature subjection to social, and other discursive contexts, starting *from within* technological assemblages instead.

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[156] See Paul Riceur, Time and Narrative, xxx

Bobnic: "How does the knowledge of media archaeology differ from technical knowledge and its corresponding scientific paradigms?"

Media archaeology, first of all, is as close to technical knowledge and its scientific paradigms (in the sense of Media Science, as differentiated against Media Studies in the cultural analysis sense) indeed. But being academically located within the Humanities, technical analysis is not its aim in itself (for engineering improvements), but as a starting point to couple such technical knowledge with epistemological questions, starting with Heidegger's notorious "Question Concerning Technology" in itself.

Bobnic: "[C]an you list some other artifacts from your collections and the concepts and questions you operate with when working in the lab and fundus? How do you collect artifacts? Do you also include code and software, as for example in online repositories such as GitHub – is this method suitable for your engagement with media?"

Flusser, in his book on "things and non-things"[157], has already discussed computer programs (and their scripts) as a challenge to object-centered media-artefactual collections.[158]

Bobnic: "[H]ow do you (or how would you) approach different algorithmic methods and their development, for example, recommender systems of the streaming platforms, or even more concretely, social media, from the perspective of radical media archaeology?

Foucault himself directly addressed the "techniques of power", and the cybernetics of "governmentality" (which is a verbal pleonasm, of course). As is demonstrated in a recent book which opens the "black box" of smart phone photography[159], the usage of technology is not simply a "social media" question in terms of discourse and political content (such as democracy vs. censorship), but there is a micro-political level of freedom in technological usage as well.

Bobnic: "It seems that media archaeology is more akin to art and aesthetics than to politics or economics – why is this so? Besides that, what would be a proper media-archaeological art practice?

There is explicit practice-based artistic research about the *arché* of media technologies indeed, such as Paul de Marinis' abuses of the Edison

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[157] Vilém Flusser, Dinge und Undinge. Phänomenologische Skizzen, München / Wien (Carl Hanser) 1993

[158] On the preservation of software, see Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing Vol. 4 No 3 (1992), 206-210

[159] Wolfgang Hagen, Neudasein. Essays zur sozialen Epistemologie der Smartphone-Fotografie, Berlin (Kulturverlag Kadmos) 2021

phonograph principle, inter alia, or George Legrady's intallation *Pockets full of Memories* based on self-organizing maps (SOM) as machine memory.

Besides, there is a political bias in radical media archaeology indeed - even if not in the superficial discursive sense of media content analysis. The media-theoretical research colloquy *Media in our Sense*, at Humboldt University, recently (June 2021) discussed Karl Marx' so-called "Machine fragment", its cybernetic insight, and data-driven algorithmic capitalism *avant la lettre*. Media archaelogy is discovering the political in the micro-technical event, its "microphysics of power in the sense of Deleuze / Guattari, and Foucault.

At a recent online-lecture at Wuhan Technical University in China (may 2021), "live"-streamed from the Media Theatre of Humboldt University, the "question concerning technology" has been politically addressed indeed. Just like Joseph Needham's seminal comparison of the history of science in the East and in the West[160], the question concerning philosophy and media epistemology of techology[161], and how "modern" occidental science (Needham) is entangled with the liberty of scientific thought and freedom of techno-mathematical experimentation simply for its own sake of knowledge, is an intervention into what Chinese government would call an "inner affair" of China indeed.

Finally, there is an academically "policital" concern of media archaeology regarding the current wave of "digitization" as dominant discursive claim triggered by the pandemic crisis. The related transformation of the essence of University by online-teaching needs media-theoretical self-reflexion indeed.[162]

Bobnic: "One of the distinctive features of media archaeology is that the real media archaeologist are machines themselves. Media understand media, our knowledge of it is only a residue."

Bobnic: "Can you speculate about the future of media archaeological methods? For example, how should future media archaelogy adress Internet, or a phenomenom like Youtube?"

On the one hand, there is an obvious media-archaeological reminder of the material, and economic infrastructures of the Internet and Social

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[160] Joseph Needham, The Grand Titration: Science and Society in East and West, London (Allen & Unwin) 1969

[161] Yuk Hui, The Question Concerning Technology in China. An Essay in Cosmotechnics, Falmouth (Urbanomic) 2016

[162] See W. E., Geistervorlesung [Ghost Lecture]. Techniknahe Analyse in Zeiten der Pandemie, edited by Thomas Fecker / David Friedrich, Glückstadt (vwh) 2021

Media - which is both technical (fiber optical cables, energy consumption of server farms) and logical, in the literal techno-logical sense of Internet protocols (Galloway), down to the "geology" of highly integrated media technologies which require rare earth minerals that are connected to economic exploitation in the concrete sense, and as well to current theory of the "Anthropocene"[163].

More media-epistemically, for social media communication channels like YouTube, media-archaeologically reminds of the electronic TV "tube" metaphor, first of all. In accordance with Marshall McLuhan, the analytic focus is on the *media* massage - not the "social content" of YouTube videos. There is nothing less "social" than so-called "social media". They increasingly reduce the human factor to a mere provider of "big data" to feed Artificial Intelligence, and recommender algorithms or other "profiling" intelligence. Once children have been "coded" by the rather violent acquisition of articulated language (even before writing in sub-semantic alphabets), they have been tuned "social" - but in a techno-logical sense. Nowadays, stochastic data pattern analysis de-socializes technology-based communication.

Especially the very Zoom video conferencing software which enabled the question & answer session between Media Archaeological Fundus in Berlin and the Ljudmilar art and media space in Ljubljana demands for a critical media-archaeological analysis of its techno-logical realities, which turn the logocentric Platonic "dialogue", and familiar academic discussion, into a technical, cybernetic circuit - a (dia-)technologue.

Media Archaeology in Practice:

AGAINST THE "DEAD MEDIA" METAPHOR. "Objectified" and Processual Media Analysis in the Media-Archaeological Fundus, and "Radical Media Archaeology" as its Research Method[164]

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[163] See Jussi Parikka, A Geology of Media, Minneapolis / London (University of Minnesota Press) 2015

[164] Central arguments in the following presentation of MAF's philosophy have been discussed in, but have now been extended, revised, and translated, from three original interviews: a) "5 Fragen an Prof. Dr. Wolfgang Ernst – Medienarchäologischer Fundus, Institut für Musik- und Medienwissenschaft der HU Berlin", Interview: Julia Kleinschmidt https://sammeln.hypotheses.org/941#more-941; b) "Archives, Materiality and the 'Agency of the Machine': An Interview with Wolfgang Ernst" (by Lori Emerson), edited version, web page "Library" (Library of Congress, USA), https://blogs.loc.gov/thesignal/2013/02/archives-materiality-and-agency-of-the-machine-an-interview-with-wolfgang-ernst; c) "An Interview with Wolfgang Ernst" (by Jussi Parikka), on the Media Archaeological Fundus at Media Studies, Humboldt University, Berlin;

Technical media are not simply speculative objects or discursive constructions, but they actually exist. Even if their concretizations are labelled "historic", their critical analysis demands their presence in operation and cannot be reduced to mere illustrations, or museum objects. In order to let such media be experienced in their material resistance, latencies and energetic idiosyncrasies, for students and scholars, the Media Archaeological Fundus of Media Science has been set up at Humboldt University Berlin, together with further functional spaces like the Signal Laboratory and the Media Theatre.

An actual insight into the MAF requires an illumination of its invisible background: an introduction to the research method of "radical" media archaeology. While media archaeology, in different artistic and research practices, is very often non-critically reduced to a label of retro-aesthetics nostalgia for obsolete technology like the "dead media project", or simply understood in a historicist sense (like "steampunk" in literary fiction, and narrative computer game design), the "Berlin school" of Media Science actually insists - at least in principle - on the imperative of (re-)enacting technical beings: in terms of electronic hard- and computational software "close to the machine" (which requires "hacking", the opening of the Black Box both as electronic matter, and as software) but as well in terms of conceptual media theory (identifying their techno*lógos*).

(Dis-)Locating the MAF in Hegel's House

By its sheer location, the MAF is already "situated", both locally, and conceptually: first of all, opposite of the central Berlin "Museum Island", facing the entrance of the Pergamon Museum. "Old" cultural antiquities are thereby confronting artifacts from the "new" technical antiquity of the present. And then, by coincidence from urban heritage, a bronze plaque attached to the wall at the street entrance of MAF announces that this building has, after WWII, succeeded G. W. F. Hegel's previous home, Humboldt University's first philosopher. Hegel's critique of the "mechanization" of human thought, as he knew it from contemporary proto-computers like Charles Babbage's Difference Engine in London[165], already poses a challenge to the ambitions of a technology-focused media science. At the same time, Hegel insisted on a conceptual (rather than scientific) understanding of phenomena like electricity in alliance with so-called "natural philosophy" in the epoque of German Idealism as

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entry August 22, 2016, Blog (web page) *What is a Media Lab? Situated Practices in Media Studies*, by Darren Wershler / Jussi Parikka / Lori Emerson, http://whatisamedialab.com/2016/08/22/an-interview-with-wolfgang-ernst

[165] See Friedrich Kittler, Die Nacht der Substanz, Bern (Benteli) 1989

it is associated with Goethe and notably philosopher Schelling's lectures at the University of Jena around 1800 - an approach which has recently been rediscovered in the guise of Chinese "cosmotechnics" (Yuk Hui). Whatever is articulated here will be dialectically Echoed" by the Hegelan house ghost.

No Passive Collection: Media-Archaeological Fundus, Signal Laboratory, and Media Theatre

The Media Archaeological Fundus (MAF) consists of material media-technical artefacts, partly reaching back into the 19th century.[166] But this is not a museum. The Media Archaeological Fundus is an assemblage of core technological atoms, or molecules, or "technical individuals" respectively "ensembles" (Simondon) which at first glance look historically outdated and discontinued, but become radically contemporary once they are deciphered with media-archaeological eyes, ears and minds. Any archaeology of media, in the sense of the Berlin School of Media Science, is not primarily about the past, but addresses technological objects as a continuing operative present. This leads to a non-historicist comprehension of media time.

Most important, the objects which are assembled in the MAF are still maintained functional, at least "in principle" (*en arché,* in the media-*archae*ological sense), respecting their vulnerability at the same time.

From there, the very denomination "Fundus" derives. A "fund" in the strict sense is a pool in theatre, the repository of props once produced for previous performances, but maintained for re-use in new dramatic contexts. This reminds of the departmental Media Theatre, where technical objects from the Fundus are literally re-enacted. The Media Theatre is a stage where technical media, rather than human actors, are the main protagonist. The more the actual technology of communication and knowledge media is hidden in micro-processors, the more a three-dimensional space is required to reveal such implicit signal action - such as Alvin Lucier's seminal media installation *I am Sitting in a Room* from 1969 could only unfold in a combination of physical room acoustics with its recursive recording by a magnetophone.

Back to MAF: These artefacts have not been "collected" for nostalgic reasons, but for students of media science, and media scholars, the be analyzed, and touched, in action. The MAF is by no means a "historical" or "museal" collection, but - among other issues - demonstrates that the age of technical (esp. digital) media, in its components, has been anticipated (in a non-linear time leap) much earlier. The objects have to be maintained functional (different from their exhibition in showcases of

[166] For an online insight into MAF, see www.medientheorien.hu-berlin.de

most museums of technology) in order to recognize that, for example the electro-magnetic relay as used in automatic telephone line switching, has been "misused" in early digital computing, for its "binary" quality of "on" / "off" states. And 19th century telegraphy, as discrete form of communication engineering, actually reoccurs in some of the modulation techniques of cellular (Mobilfunk) devices.

The Media-Archaeological Fundus, together with the Signal Laboratory, and the Media Theatre, constitute a tri(techno)logy for the analysis of media. Complementary to the MAF which has a priority in archaic media techniques, the Signal Laboratory, as indicated by its very name, focuses on electronic, and digital, signal processing, with an emphasis on early computer (game) platforms, and early home computers, in combination with its original programming languages.[167]

In the design and structure of the Humboldt University Signal Laboratory, the relationship between media archaeology and digital preservation becomes not just visually evident on display, but operatively accessible.

The Media-Archaeological Fundus is no "collection" of technical artefacts in the traditional sense, like so many private collections of, for example, antique radios. The imperative for MAF's existence and maintenance within a University context is strictly academic. But what is academic regarding a brute technical object? It is the implicit material, and logical knowledge which invites to be media-analytically unfolded, to be made explicit in media-epistemic terms.

That is why its (online-accessible) *Katalógos* is no simply inventory with technical and historical metadata for the single items, but a *catalogue rainsonné* in a different sense: a focus on their media-archaeological momentum and epistemological surplus value, as their mean "reason" to be selected for the MAF.

The reason for assembling technical objects in the MAF is to provide insights into the essence of technology, not primarily to document technical history and its original historic artefacts, as it is achieved by technical museums (such as the Deutsches Technikmuseum in Berlin). In contrast to technical masterpieces which are kept in museum showcases but are not allowed to be touched, even less re-enacted, for media-scientific analysis and education, a different set of objects comes into consideration, which might not be attractive, at first sight, from a public point of view, but is highly interesting in terms of close knowledge-oriented investigation.

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[167] The Media Archaeology Lab for vintage computing in the context of electronic poetry that Lori Emerson runs at the University in Bolder bears a strong resemblance to the Signal Laboratory in Berlin. See https://loriemerson.net/media-archaeology-lab

MAF's most obvious (De-)Monstration: The Ernemann Cinema Projector

Media as the condition of apparently immaterial signal communication have a very material presence indeed. The (de-)"monstrous" film projector within the MAF, dating back to mid-20th century, for example, is not kept for its obvious demonstration that it unrolls celluloid reels, but for an insight into its more sopisticated mechanisms:

Fig.: Film projector (Ernemann factory, Dresden) [Filmprojektor-Ernemann.MAF.jpg]

What becomes apparent by means of the close technological insight is that visual movement does not unroll continuously, but every photographic frame is made to stand still for a fraction of a second. From there, media-epistemic questions arise, which go beyond perception-oriented "cinema studies". It rather triggers a discussion about how the cinematograph "treats time as discrete" (an obvious allusion to Alan Turing's advice for digital computing). The "Maltese cross" freezes the continuous flow for a moment, while a rotating wing disc serves to increase the image projection frequency - which deceives the relatively slow human visual perception to "smooth" its very discontinuity into the delusion of a continuous movement.

An ancestor of this film projector by the same company Ernemann, from 1910 (as preserved in Technische Sammlungen Dresden), the "Imperator", still reveals the rotating wheel in open, naked technological display.[168] That leads to another core imperative in the philosophy of the MAF: Once accessing this space, the technical objects are radically dismantled from their cover, in order to reveal their technological essence, against the perceptional seduction by the surface or interface which rather directs human attention to the "historical" associations of object design style. The MAF works against kitschy media surfaces to get users to understand the underlying workings of, say, Heidegger's radio of which the MAF does not keep the "original" but two type-identical instanciations (the Grundig Musikgerät) - one in its user appearance (as ciritically descibed by Heidegger on "tuning to the world"), and one dismantled from the cover to reveal its technological essence. Heidegger in fact never cared for the electronic vacuum tube - which makes all the difference between the "question concerning technique" and "technology". Here media archaeology radically goes, with Heidegger, beyond Heidegger. Such equivalent radios are as close to the original

[168] See https://de.wikipedia.org/wiki/Ernemann#/media/Datei:Filmprojektor_Imperator_TSD_(1).JPG, accessed April 10, 2021

auditory scene in the philosopher's Black Forest mountain "hut" as the "original" itself.

More important even, the opening of the Ernemann film projector's "black box" (by a transparent window) reaveals that this device can by no means be reduced to an opto-mechanical apparatus, but incorporates a piece of electronics already: the photo cell which is able to transform the marginal "light" inscription at the margin of each frame into audible tone. Thereby, the film projector is reavealed as a rather complex media device.

Revealing the "Bit": The Flipflop Demonstrator

In a world where communication media are miniaturized to the max, and microprocessors become ubiquitous, but hidden to unrecognizability in the Internet of Things, "users" - even students of Media Science - lose contact with what happens *within* such technologies. An assemblage of archaic media still reveal such principles, but in contrast to miniaturized component such as transistors of Integrated Circuit chips, they do it in a haptic, macro-perceptible way. Therefore, media archaeology is not primarily directed to "dead" or "forgotten" media from the past waiting to be rediscovered or even to be excavated, but archaeology is rather understood in its old Greek sense of *arché*, which is not necessarily about beginnings, rather about the essential. Media archaeological analysis reduces so-called "media" to their technical essentials, in order to keep them comprehensible.

While most users, in everyday media culture, count the capacities of their "smart" devices in Megabytes, the idea of what is "a bit", and where it actually takes place, recedes.

Fig: Flipflop Demonstrator (Henry Westphal, TIGRIS Electronics, Berlin) [Flipflop-Demonstrator-Westphal.jpg]

Most humans only know them as symbolic "zeros" or "ones" which, of course, is not the case for the technical existence of binary information units. Therefore, the MAF has been granted, on loan, the "Flipflop Demonstrator" which has been built by Henry Westphal (from TIGRIS electronics company, Berlin, together with a student group at Technical University, Berlin) for educational use. The earliest known binary coupling, consisting of two cross-related triode vacuum tubes (which has been a "misuse" of their contemporary development for radio transmission and reception), as documented in a circuit design in 1919, has been replicated. All of the sudden, one "bit" becomes ma(t)eRealized and (more than just analytically) accessible, immediately revealing its material, and energetic frictions and electronic idiosyncrasies of binary

behaviour, once this conceptual information unit becomes technically embodied.

The operative presence of media-archaeological artefacts, once they have been taken from the MAF shelves to the central workbench for their demonstration in action, can usually not be preserved *via* a "live-"streaming transmission, since hereby it becomes a simple external iconic representation. But in the special case of the Flipflop Demonstrator, its digital telecommunication does not simply transform its materiality to pixels, but returns from within such pixelized representation itself, since any pixel ultimately grounds in material micro-flipflops ("bits") in the integrated circuit chip where techno*lógos* takes place.

Media-Epistemic "Toys": the KYBERNET

For another object, a toy car produced by Piko in the mid-1970 in the former GDR, it might, at first sight, not be obvious what makes it eligible for the academic MAF. It is actually its very name, which metonymic for its operation: the KYBERNET.

This battery-driven car could be "programmed" with elementary units to decide on its direction, which then were successively "processed" by the car wheel mechanism. It therefore becomes an automat. Even if lacking an actual mechanism for negative feedback error correction, the KYBERNET thereby, in principle, served to playfully adjust children to the principles of cybernetic government which, in both East and West, for a whole epoque dominated avantgarde thinking.[169] Its computational equivalent, then, is the "Turtle" graphics in the programming language for "children": Logo.[170]

The playful approach to technological thinking, as it is represented by a number of "toy" artefacts in the MAF, thereby shares, with the media-archaeological approach, its strategy of reducing complex media to their essentials.

How a Cigarette finds its Way into a Technical Collection

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[169] For a recording of the KYBERNET actually "on tour" see the YouTube channel of Media Theories at Humboldt University, Berlin, https://www.youtube.com/watch?v=fKlp1apxgDw&list=PLv5ZCBPmpgvhUdiKREiAN3SIMV8OY00bS&index=3. Video: Thomas Fecker

[170] See Stefan Höltgen et al., A Case of Toy Computing. Implementing Digital Logics with "Minecraft", forthcoming in: A. Adamatzky (ed.), Alternative Computing, Singapur (World Scientific) 2021, *forthcoming*

Another object to be demonstrated from the shelves of the MAF, at first glance, does not evidently reveal the reason how it found its place in a media-archaeological context: a classical filter cigarette.

It is a little detail, the little gold stripe at the upper margin of the filter, which - in a kind of material metonymy - links it, unexpectedly, to the invention of the magnetophone for sound recording, in the mid 1920, by Fritz Plaeumer in the city of Dresden. At that time, as a member of a cigarette company, Pflaeumer had been concerned with the application of metallic filters against intoxication by smoke. From that, he suddenly derived that if metallic dust can be fixed to (cigarette) paper, one could as well magnetize such paper by the varying current of electric voices, as known from telephony, by the well known core media operation of electro-magnetic induction. Thereby Pflaeumer invented what he called the „singing paper“, which later became the magnetic tape. Such unexpected perspectives reveals the contingencies (or "strange techno*lógos*") of technical individuations. It is from such apparent "curiosities" (like in an ancient Curiosity Cabinet), that media-epistemic insights can be derived. This is a core issue in the philosophy of the Media-Archaeological Fundus.

Towards a Material Media Philology

Working and experimenting with technical objects - be it material hardware, or technical diagrams, or computational source code -, differs from purely "philological" text work as it is executed in most disciplines with the Humanities. Like most disciplines in the Humanities, the core academic way of expression in Media Science as well is based on spoken words, and written texts. But in the specific educational concept of Humboldt University, as developed in early nineteenth century, next to the seminar room and lecture hall, and the library, each disciplines comprised a so-called "Apparat(us)" of material demonstration objects (such as a collection of plaster casts of ancient statues for Classical Archaeology).

Several initiatives and programs from political stewardship or scholarly foundations currently aim at “excavating” forgotten, or hidden, collections from German academic institutions, to make them visible, and accessible again, to the research community. This refers especially to the many university collections attached to single disciplines, such as the treasures of ancient color slides in art history departments, which are now massively digitized. The slightly different philosophy of the MAF is that it does not claim to offer unique artefactual collections but rather wants enforce media-active research for theoretical, and historical aspects which cannot be reduced to textual documentation, but aks to be tested, and experienced, in their material evidence. For the circuit

diagram of an Analogue Computer, for example, it is not sufficient to exist on paper only. It rather invites to be implemented as operative diagrammatics, as it is exercised in the Signal Laboratory.

Especially for media science, it is mandatory to be reminded that "media" cannot be reduced to a mere theory or discourse, but actually exist as technological "time objects" (a term borrowed from phenomenologist Edmund Husserl). Their essence unfolds only in action; therefore it does not suffice to simply illustrate them as images. A visual text illustration does not reveal the actual medium.

The "Berlin School of Media Science" (different from most "Media Studies" at other universities that focus rather on Cultural or Communication Studies) is known - and notorious - for being close to technology, in its double sense. We need technical objects to be near, having them literally "at hand" (an expression which asks to be further differentiated with Heidegger's distinction, in Time and Being from 1927, of "ready-at-hand" and "present-at-hand").

Even more in times of the Internet, so-called "virtual reality" and "immaterial" information culture, it is imperative, for media analysis, to remind and insist, in an enlightning sense, that highly advanced digital technologies still "ground" in 100 per cent electro-physical materiality and energy, which - for any "understanding" of media - needs to be experienced in all its resistance (very concretely as elementary "resistor" in electronics, indeed). The best way to make such an experience is by the tactile "opening" of a medium for repair, in search for its defects (where "the real" comes to speak). In this crude form of "analysis", the principles of media technologies can be apprehended.

Different from, for example, philosophy itself, "media" are, most of all, concrete objects or "agencies", which the MAF, as well as the Signal Laboratory, and the Media Theatre, remind of.

In order for a technical device to become an actual "medium" in the cultural (not merely physical) sense, it needs to be experienced in its *operative* form of existence - which any merely descriptive, textual, of figurative documentation, fails to communicate. Pieces of metal or other kind of "hardware" are in a *medium* state only once they are set in execution, that is: when signals are transduced, or (digitally) processed, within. On the other hand, media-theoretical texts can express a techno*lógos* which the artefact itself does not explicitly pronounce. But the best kind of media *theoría* results from the immediate - or algorithmically "mediated" - contact with the actual mateReality of the technical, or logical, object in action: kind of a *transitive media theorizing* which emerges not after, but from within such a mind / matter contact. That is why such an assemblage of really existing media devices is not

simply ornamental, or nostalgic, but essential for a discipline which does not reduce media to "texts" (be its diagrams, or code) only.

On the other hand, different from polytechnical universities or computer science, which knows electronic technologies much more profoundly in its escalations and details, media science is (still) satisfied with its location within the Humanities (good old "Philosophische Fakultät", in German university tradition). Since different from the academic education and training of mathematicians and engineers, humanities pose different kind of questions regarding the technological object, for which the strictly "technical" disciplines, at another faculty, rarely grant educational time and space. Media archaeology generates less pragmatic but knowledge-oriented questions and provides critical insights - since "opening the black box" does not refer to the concrete object only, but to their epistemic enframing (the Heideggerean *Gestell*) as well. Media theory elicits epistmic sparks, so to say - both metaphorically, and concrete in terms of oscillating electro-magnetic waves.

Admittedly, media *theory* finds its most precise expression *on* media in the verbal, or textual form. But in order to let the techno*lógos of* media be co-expressed, it requires the running media machines (be it material devices, or the implemented source code).

Media Materiality, and the Agency of the Machine

Media archaeology, in its concern both for the material artefact, and its digital "archive", actually deals with the agency of the machine - with the "machine" being understood here both in its thermodynamic, electronic, and algorithmic ("Turing machine") sense, but not extended to discursive metaphers for social agencies (in Guattari's sense).

The core task and justification for the MAF to be maintained within the Humanities of Humboldt University is to encourage students and researchers of media science to witness, and participate in, the performativity of technological objects preserved in the MAF. Against the nostalgia or fascination with "dead media" - as in "steampunk" aesthetics -, its main issue is to have the items re-enacted (with the prefix "re-" not necessarily relating to the past, but the operative media function).

The bias of MAF based teaching is to train students to resist the nostalgic or even melancholic impulse which is normally associated with so-called "dead media", and to discover the retro-futuristic element instead. The electric telegraph, e. g., operates with discrete signal transmission: a code which after an age of AM media (such as radio) returned in unexpected ways. Whereas digital data transmission is much too fast to be perceivable directly to human senses, the classic telegraph “dots and

dashes," when connected to an acoustic mechanism, may serve as a way of slowing down and sonifying the nature of coded signal transmission. Retro-futurism, understood in this way, hints at a non-linear relation between past and present media technologies, a short-circuiting of media tempor(e)alities which escapes traditional, narrative history of technology. Instead of one media system resulting from another, there are sudden recursions. For that reason the artifacts arranged on the shelves of our MAF at first glance look like a curiosity cabinet – since they are grouped together according to rather media archaeological and media epistemological criteria rather than in ways familiar from museums of technology.

Ageing Physical Media vs. "Timeless" Technological Insight

For obvious reasons many of the machines in the MAF do, or may soon, no longer work. Therefore it is mandatory to record them in action as long as their are still operable. The media-archaeological art is in identifying which aspects are to be documented: not simply the "phenomenological" appearance, but its function core, for future (substitute) re-enactment by functional equivalents.

In a relentless, "radical" media-archaeological perspective, the machines in the MAF that have ceased to function, whose active material processes we no longer have access to, are no more valuable tools for teaching, and research. Still, no resignation is justified here. If machines and electronic elements in the MAF do no longer work, this actually is a welcome challenge for the teaching and research process. Taking machinic elements apart in order to try to reanimate their function is a way of media analysis in the strict sense: not restricted to textual interpretation but to diagramatic reading of circuit plans and material hermeneutics (media-archaeological philology). If it comes to source code in the case of ancient computers, we can take the name of the machine-orientated programming language Assembly literally and dis- and re-assemble it.

The media-epistemological "credo" that a technical apparatus is in *media* existence only when being operative requires at least the effort for re-accessing its material processes – even by simulation or digital emulation. The act of repairing dysfunctional media-archeological artifacts is didactic. Practically speaking, in most cases the re-animation of valuable technological antiquities (like an early TV set) can, for curatorial reasons, only happen a few times without ruining the original ingredients completely. Our strategy is thus: repair once, repeat many times – by recording the singular event in sound and video. The "operative" videos attached to the online presentation of the MAF are

therefore not just an illustration, but a form of argumentation in another medium than the physical collection.[171]

MAF "Online"

The online components of the MAF are not simply the public side of an otherwise university-internal academic institution. The MAF web page is rather understood as useful extension of its media objects for aspects which are better expressed in its different "digital" form.

This brings us to an apparent paradox of this actual presentation of / from the MAF in the video conferencing format Zoom. How can a *streamed lecture* maintain not simply a intransitive ("about", as meta-language), but transitive media-archaeological relation to such technical objects? The answer, though, in the double sense of techno/logy, splits into the hardware and software aspect of media.

A simple digital "representation" of the technological artefacts would be rather poor substitutes for the material object. The theory underlying MAF-related teaching and research extends into active remembrance (German *Erinnerung* as active "appropriation" or "interiorization") rather than to passive storage regimes of memory (German *Gedächtnis*) - which is a differentiation which the MAF, once more, owes to its "house spirit" Hegel. The MAF web page is not primarily addressed to "social media" (even if resulting tweets, or blog-posts, are welcome), neither does it claim to build up to an online sound and image archive, for browsing and search engine-based media histories.

Ideally (even if not yet fully achieved) the "virtual" MAF extends the "real presence" one rather for media-archaeological aspects which can better expressed in algorithmic terms. Still. the main feature of the MAF is grounded in the materiality (called “hardware”) of media artefacts – while the Signal Laboratory is archaeologically rooted in the source codes of computer programs. Only when thought together, this adds to a more comprehensive, literally techno-logical insight, since the memory regime of media culture is both material and symbolic, both engineering and mathematics. The configuration of artefacts in the MAF, guided by rather idiosyncratic media-epistemological criteria of teaching and research, does not constitute an archive, and its online presence is not meant to contribute to audiovisual archives as represented in the Web but rather a different form of audiovisual argumentation. Rethinking dynamic digital memory requires different platforms.

Media Archaeology's Cutting Edge: Techno-Mathematics

[171] https://www.youtube.com/channel/UCOks0hDQ02OK2yDKj2QOWTw

In its resistance against the metaphoric seductions of the archaeological excavation[172], and the idea of an "excavation" through layers of history, the reverse engineering which takes place in the MAF and the Signal Laboratory is less narrative, or recounting. It is rather counting – as mathematics, and as programming – which is part of a media-archaeological practice. Therefore, a techno-diagrammatic (electronic circuitry), and mathematical (programming) mode of thinking plays out in the teaching, investigation, and research that takes place in both the MAF, and the Signal Laboratory

That media-analytic ambition leads from purely "historical" to "radical" media archaeology. So what is "radical" in media archaeology of the Berlin School kind? Different from "historical media archaeology", its analysis - at least for an "epochal" (Husserl) moment - is suspended from immediate, and premature historical contextualization. It is rather in search of something like the "techno*lógos*" where technology articulates itself (both symbolically in circuitry and algorithmic procedures, and in the physical real), In order to achieve this, it has to investigate the technical object (and process) as "radical" as possible from within - be it materially invasive (for the "analogue" media case), or non-invasive in terms of emulators (for "digital" computing).

[What separates "soft" from "radical" media archaeology? While "soft" media archaeology, as it is achieved by prominent colleagues in "historical" media archaeology, primarily deals with "dead", or neglected media from the cultural past(s), for "radical" media archaeology, the epistemic "question of techno*lógos*" - in obvious allusion to Heidegger's rigour[173] - is of priority, in order to reveal the double nature of - in the literal meaning - techno/logy.]

Such an analysis necessarily refers to both hard- and software, and therefore does not reduce its objects of analysis to the sheer materiality of media, but comprises their mathematical logic as well. Media-archaeological research therefore requires both hands-on, and diagrammatic, analysis.

While vintage media devices, as objects, easily invite for a nostalgic attitude for past media where technology could still be materially experienced, contemporary media science must insist on a transgression. While in the Media-Archaeological Fundus (as well in the Signal Laboratory) students still learn to solder electronic circuitry in order to experience how, for example, a radio resonant circuit comes into

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[172] See the Dead Media (online) Project, as initiated by science fiction author Bruce Sterling in 1995; http://www.deadmedia.org/

[173] See Martin Heidegger, The Question Concerning Technology and Other Essays, New York, NY (Garland) 1977

existence, the equivalent to soldering with mateReal devices today is symbolic programming of computer software. Software, though, is not haptically accessible by putting objects an a shelve any more, but rather through logical analysis. Beyond "dead media", radical media archaeology extends to the mathematical aspects of computer science, and its "virtual" machines, while at the same time insisting that "there is no software" (in Friedrich Kittlers sense). In the end, every "bit" is embodied in voltage which operates in electronic hardware. The "radical" here, in the double sense of a techno-mathematical media analysis, refers both to the mathematical square root symbol, and the material grounding of all technical media operations - even in times of "invisible" computing.

As opposed to pure nostalgia for haptic "analogue" media as a retro-effect of otherwise "immaterial" digital culture, media archaeology has a mathematical cutting edge indeed. In the above mentioned play with words, archaeology (the science of *arché*) is not just about media-historical origins, beginnings and archaic principal functions, but it is also about the “square root.” As an example of the role of the mathematical mode of media-archaeological reasoning in the MAF, artefacts from telephone technology (an electro-mechanical relay element, a variation of Strowger’s Automatic Telephone Exchange or a Manual Telephone Switchboard) are juxtapose with devices from early electronic computing to demonstrate how the hardware performs discrete numerical operations – nowadays almost exclusively ones that are associated with the digital computer – that have been literally transferred from a voice communication technology, just like the vacuum tube which had been invented for amplification of weak electric signals but was later “mis-used” in Flipflop circuits of early stored-program computers. Such hybrid cross-overs defining “the mode of existence of a technical object” (in Gilbert Simondon’s terms) media-archaeologically remind us of the two-faced meaning of *technology*: *techné* on the one hand (impressions of physical hardware) and *lógos* on the other (the logical and mathematical intelligence resulting in software).

The *Arché* of the MAF

Instead of story-telling in the mode of "how the idea for the Media-Archaeological Fundus originated", media archaeography[174] actually recalls what functional ratio made it mandatory for teaching Media Science at Humboldt University. Its (then) "Seminar" was founded in 2003, replacing the former seminar, Theatre Studies. All of a sudden, spaces like the student practicing stage and its related fund of objects for rehearsal were empty. This was the ideal moment for the Berlin school of

[174] See Moritz Hiller / Stefan Höltgen (eds.), Archäographien. Aspekte einer Radikalen Medienarchäologie, Berlin (Schwabe) 2019

media studies (insisting on the materialities of communication and epistemic technologies) to claim such rooms under new auspices. The former experimental "studio" became the Media Theatre where technical devices themselves become the protagonist, and the fund became the space for a collection of requisites of a new kind: media archaeological artefacts.

When the new curriculum in Media Studies was finally authorized in the Faculty of Philosophy, it soon turned out that even with its emphasis on academic questions, no teaching of media can be reduced to lectures and texts only. However complicated the definition of “media” might be, as technological media (the focus of the “Berlin school”) they really exist(ed) and need to be experienced in performative ways. Thus a Media Theatre was installed (a room inherited from Theatre Studies) where the media are meant to be the main actors, linked with a Signal Laboratory for data processing and with a library of audiovisual sources (Mediathek).

All this needed to be grounded in the material presence of archaeological media technology – be it archaic in the sense of “dead media,” be it illustrative in terms of the key elements of media technology, be it essential in terms of principles (like the enlarged version of a flipflop circuit to store one “bit”), be it experimental in terms of techno-epistemological questions. Following my definition that such items need to be displayed in action to reveal their media essentiality (otherwise a medium like a TV set is nothing but a piece of furniture), it required an assembly of past media objects which teachers and students are allowed to operate with and to touch upon – a limit for curators and visitors in most museums of technology.

Starting with an empty room in the basement (just like a gallery for conceptual art nowadays), the Media Archaeological Fundus has since been populated with technological media elements which at first glance look outdated but become retro-avant-garde once they are deciphered with media-archaeological eyes and minds – such as a telegraphy apparatus which turns out to be “digital” *avant la lettre*, surpassing the age of so-called “analog” signal processing media like the classic electric telephone.

Technological media (both in communication and in non-communicative contexts) are not mere cognitive constructs but really exist. Any media theory therefore needs to be archaeologically grounded in the twofold presence of media technology, that is, material (engineering) and symbolical (mathematical, logical, diagrammatic); in archaic artefacts (which are never “dead media”), in illustrative key elements (like the enlarged version of a flipflop circuit to store one “bit”), and in essential operative principles (algorithmic source code). All this becomes experimental in terms of techno-epistemological questions. Technological items need to be analyzed in action in order to reveal their media

essence; otherwise a TV set is nothing but a piece of furniture. Therefore for academic media analysis it requires a pool of past media objects which teachers and students are allowed to operate with, different from the “don’t touch” imperative in most museums. The Media Archaeological Fundus is populated with core technological molecules which at first glance look outdated but become a-historical once they are deciphered with media-archaeological eyes, ears and minds. A telegraphy apparatus turns out to be “digital” *avant la lettre*, surpassing the age of so-called “analog” signal media like the classic electric telephone.

"Grounding" the Media-Archaeological Method in Techno-Didactic Components

Teaching of media cannot be reduced to lectures and reading only. When students are writing papers on the difference between cathode ray tube-based television and the digital videos of YouTube, they first of all have to experience what the techno-materialities of analog television haven been. However complicated the definition of “media” might be, technological media objects (the focus of the “Berlin school” of media studies) really exist(ed) and need to be experienced in performative ways. That is why, in addition to our academic students, a bunch of media artists come to visit and to make use of the Fundus as well.

For academic media analysis it therefore required the establishment of a Media Archaeological Fundus which allows for students (and teachers) to literally “analyze” media, not only in abstraction but literally to take M-E-D-I-A apart (the ancient Greek meaning of *analysis*).
We have an impressive Technological Museum in Berlin which displays most precious originals from media history. The problem is that visitors obviously are not allowed to investigate such apparatuses manually, and for curatorial reasons these objects will not be put back into operation. But a technological medium which is not signal processing is not in its medium state at all but simply a piece of metal. For academic media analysis it therefore required the establishment of a Media Archaeological Fundus which allows for students (and teachers) to literally “analyze” media not only in abstraction but literally to take them apart (the ancient Greek meaning of *analysis*). That is why most of the artefacts in the shelves have been deprived of their design cover. The Fundus is not ordered according to the familiar mass media sets of radio or television or computers from past days but primarily consists of what is media-archaeologically considered as its electro-mechanical and electronic core elements: non-intuitive, even monstrous, artefacts in the best sense of a technological curiosity cabinet (*Wunderkammer*). A relay which was familiar in telephone communication and later in the first generation of electronic computing serves to demonstrate how media elements cross the borders and undermine conventional mass media segmentation; this

incites to consider new non-historiographical philosophies of how media exist in time. Such a pool is meant to represent both aspects of media-archaeological *artefacts*: the material “analogue” devices and the new type of digital artefacts such as glitches, known from defect pixel representation on computer screens. Therefore the Fundus is linked with a Signal Laboratory for the close reading of data processing.

The Delicate Difference to a "Media Lab"

There has been an explosion of instituting Media Labs, starting at MIT in Boston in the 1980s, then spreading to other places. Some of them are recently more specifically related to Digital Humanities, some to Design, and other activities. The Media-Archaeological Fundus, though, in some way differs from the idea of many of such “labs”, which are mostly reduced to a mere assemblage of computers in an otherwise empty room. For its twin institution, Media Science at Humboldt University proudly insists on the Signal Laboratory.

I personally got my first impressions of such "labs", as “artistic-academic” assistant teacher and researcher in the late 1990s, from the so-called Media Lab at the freshly founded Academy of Media Arts in Cologne. In those days computers for digital image sequences (rendering) were still costly and a privilege to students of such an educational institution. Nowadays every student with media-artistic ambition can install his own “lab” with free software on his private computer. I want to add, though, that the yearbook of the Cologne Academy for which I acted as an editorial production assistant has been called “Lab” as well (*Lab. Jahrbuch für Künste und Apparate*). In the academic context, material analysis of technological devices is always coupled with its epistemological reflection, which is still best expressed in words and texts.

Nowadays, so-called "labs" spread around the institution in an almost inflational way. But a significant shift of emphasis has taken place: The traditional scientific laboratory has been a very material theatre for creating “epistemological objects” (as described by Canguilhem and Rheinberger); nowadays experimentation takes place almost exclusively in the calculating of space (computer modelling). Most Digital Humanities "labs" which employ algorithmic research to big data for new kinds of information within the humanities disciplines miss the material aspect of cultural analysis which first of all starts with the hardware employed for research itself. The most intelligent algorithm only becomes operative when implemented in the real world (that is: real time) of hardware architectures. Big data is still being processed by electronically-driven computers in the most material sense. Digital Humanities therefore require synchronous self-critical reflection of their own technological

condition – a kind of "humanities of the digital"[175] in the sense of material media philology and classical auxiliary sciences of material investigation. What has been paleography or numismatics on the traditional humanities nowadays now becomes media forensics.[176]

Toward the Practices of Hacking

In so-called hacker spaces, and artistic research practice such as circuit bending, issues of openability of technologies (both in terms of code and hardware) are raised, alongside even environmental issues (such as repairing old electronics). But here, the difference between an academic and a more public situation of a MAF becomes evident. While such projects like hacking are often more political in their bias, the opening of the Black Box of technologies, at university, serves for rigid media analysis, and its allmost "pure" (Kant: "interessenlos") will for knowledge.

The best way to analyze a technological medium is to take it apart and to re-assemble it. As an operative form of media research this does not lead to destruction but rather gives a more precise understanding of what, in the philosophy of the 1980s, became known as de-construction. Re-assemblage as well allows for new combinatorics. To think media in relation to its technological elements is like thinking the alphabet in relation to spoken language: It allows for analysis on the sub-semantical level and leads to re-combinations in techno-poetic ways. Together with its sister laboratory, the Signal Lab, the Media Archaeological Fund makes transparent that what used to be hard-wiring of technical artefacts nowadays is programming. The very term for symbolical coding which remains close to the language of the machine itself is plain text here: ASSEMBLY.

Hacking and circuit-bending is a form of media-political criticism, of an economy and artistic experimentation which mostly takes place outside the Humanities departments of academic universities. But when coupled to media studies, the focus of interest is a different one: to reveal and verbally make explicit the knowledge which is implicit in technologies (both in the material and the mathematical sense). Media archaeology as academic practice is applied epistemology: it does not leave technological expertise to engineering and computing sciences alone but learns and teaches how to create sparks of knowledge from objects in order to translate this into discourse for critical reflection.

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[175] An expression owed to Jan-Claas van Treeck, Berlin

[176] See Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008

How the Fundus relates to the "Museum" Tradition of Cultural Heritage

Concerning the cultural heritage of technology (which is about actual signal transmission rather than outmoded symbolical "tradition"), the MAF offers an alternative “model” outside the museum concept. In that concern, it reaches beyond it internal function as institution within Humboldt University.

By coincidence of its recent transfer from former Sophienstraße in central Berlin, it happens that the Media Archaeological Fundus is now physically located not only opposite, but even in dialectic contrast to the Pergamon Museum on Berlin's "museum island", which preserves archaeological objects from various ancient cultures. Media-archaeological times, in that other sense, are the new, recent "antiquity" of our present, just as Walter Benjamin, in his "Theses about the Notion of History", defined recent nineteenth century already as the "antiquity" to his present age.

Whereas on the Museum Island art and artefacts from antiquity are housed in the traditional museum frame, the Fundus, with its LED-based message TECHNOPOIESIS right at the front entrance (dysfunctional now, sadly), incorporates the new technological antiquity of contemporary culture like an antagonistic challenge to the classical museums. In museological terms of cultural heritage, the Fundus reminds us of how cultural objects have a different nature when it comes to technologies.

Whereas the cultural message of an ancient Greek sculpture or vase can be decoded in its pure visual and material presence once the contextual knowledge has been acquired, the value of a technological artefact can be demonstrated only when being in operation – be it the (re-)transformation of the acoustic into a mechanical signal in phonography, the implicit "sound" of the analogue video image[177], an oscillogram unfolding in micro-time by electronic sensors, or a computer program running a gaming algorithm. Just as a musical score or a theatre play only unfolds in performance, such operative (almost sonic, vibrational) museology is a new answer to advanced techno-culture which is radically time-based.

The archaic *museion* has been a “place for dancing” of the muses. Nowadays, the new museum, as Media Theatre, has to be both operative and “algorhythmic” (Miyazaki) in order to preserve technological culture – with media-archaeological re-enactment and emulators.

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[177] See Bill Viola, The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (eds.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54

(ONLY) IN SIGNALS MEDIA ARE ALIVE[178]

In many ways, the Media-Archaeological Fundus (MAF) at the Department of Media Science in Humboldt University of Berlin relates to the question if there is "life for the signals". Classical cybernetics would certainly answer "yes". Cybernetics, is not only historically respected but actually media-epistemically re-thought at the "Berlin school" of Media Science and embodied in many artefacts of the MAF. It insists that signals refer, as expressed in Norbert Wiener's seminal book *Cybernetics* [*1948], to "control and communication in the animal *and* the machine" (subtitle), traversing all borderlines between the human and the nonhuman, organism and machine.

The Media-Archaeological Fundus, together with its institutional twin, the Signal Laboratory, for sure is a space where signals take place. Media theory addresses not only "the politics of the machine" but as well the epistemic "poetics of the machine". This becomes media-archaeologically concrete here: both as material hardware (machines) and as algorithmic software (mechanisms). Machines are not reduced to the industrial age here but include the "second machine" (Gotthard Günther) that is computational reason.

The MAF makes sense to the core media-theoretical definition that technical media are in a medium state only when they are processing signals. This is not a collection neither a museum: Therefore the MAF is not only geographically but as well conceptually positioned *opposite* of the Berlin "Museum Island" with its Pergamon Museum. Against archaeological artefacts from ancient cultures, the MAF contains - in Walter Benjamin's sense - the new "antiquity" of the present age such as so-called "analog" media that have anticipated the contemporary "Anthropocene" concern with matter and energy. Different from museum objects, the technical objects that are stored in the shelves here are noth considered "dead media". When they are enacted on the central working bench, that is: once - and only once - they become signal processing devices again, they are in a true *media* state.

The core ambition of the MAF is to trigger a kind of *instant media theory*[179] that does not first arise from contemplative academic distance to the acting technical object as belated text work. Instant media theory

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[178] On occasion of *The Life of Signals?* networking meeting for POM [*Politics of Machines*] initiative (Japan) at the Media Theatre, Department of Media Science, Humboldt University of Berlin, February 18 to 20, 2025

[179] See as well the book cover of *instant theory. Die M-Fotoserie des Merve Verlags*, booklet to the eponymous exhibition an nGbK Berlin, February - April 2020, Berlin (nGbK) 2020

rather arises from its direct contact, experience and epistemic awareness of the signal-prossing artefact, as *transitive media philosophy*.

At that moment, a reference to the "house ghost" Hegel is justified, since the present location of the MAF has been the Humboldt University philosopher's private house two centuries before. Hegel defined philosophy's primary task to take care of, and permanently redefine, notions and concepts such as "media" or "signals". In electric engineering, signals are not the thing itself but material carriers of its information. The media-archaeological approach, though, does not logocentrically reduce technical artefacts to philosophical thoughts but considers them as techno-logical beings that are embodied in actual matter as energy where signals are *alive*.

Artefactual technology and organic "life" actually intersect once a human is subjected to a Magnetic Resonance Tomograph (MRT) for the purpose of medical *imaging* of inner organs. Colleague Sebastian Kotz, at the Institute of Musicology & Media Science, once proposed to include at least a *mock* MRT scanner among the artefacts of the MAF. Principally, it is already here: as radio.[180] And a literally "immersive" MRT session, for the human subject, is an almost techno-music like experience once it listens to the sound of the machine.

A special focus of the MAF is on sonic artefacts indeed that refer less to sound carriers but to the recording and replay mechanisms themselves. As it has been expressed in Morten Sondergaard's text "Interfaces of Future Authenticity", media-archivology is less about archiving recordings "as it is about storing machines"[181]. The technical configurations and codes of the machines are *a priori* "configuring our future access to the archive" (ibid.) - be it audio or visual, textual or algorithmic. Before John von Neumann's *First Draft* "conflated the computer with the biological metaphor of memory, computing devices were envisioned as 'storage' devices"[182].

In its actual location between two departments, the MAF reminds of the (still) existing institutional alliance between Musicology & Media Science at this university faculty. The MAF is literally building bridges between

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[180] "Im Prinzip ein Radiogehäuse." Sebastian Klotz, Das BOLD-Signal im MRT. Eine medienarchäologische Diagnose, in: Moritz Hiller / Stefan Höltgen (eds.), Archäographien. Aspekte einer Radikalen Medienarchäologie, Berlin (Schwabe Verlag) 2019, 63-77 (77)

[181] Morten Sondergaard, Interfaces of Future Authenticity, in: Joasia Krysa / Jussi Parikka (eds.), Writing and Unwriting (Media) Art History. Erkki Kurenniemi in 2048, Cambridge, Mass. (MIT Press) 2015, 191-202 (195)

[182] Sondergaard ibid., referring to Wendy Hui Kyong Chun, Programmed Visions: Software and Memory, Cambridge, MA (MIT Press) 2011, 8

both disciplines, with its primary medium message, in McLuhan's sense, being "acoustic space" itself. This is expressed as well by the orchestration of pure signals by the Sine Wave Orchestra. The media-archaeological sine tone, as pure signal, is "alive", before disappearing into a compound sound, in its sonic articulation that can be experience by the device of a sine tone generator that does not primarily function as musical instrument but as testing device for signal tracing in electronics.

As it has been expressed by the founder of the legendary Cologne Radio Studio of Electronic Music, Herbert Eimert, in 1954, the "pure" sine tone as such does not exist in nature: It is rather a pure technical media articulation.[183] The sine tone has been an exclusive technical condition (*arché*) for electronic music such as Karlheinz Stockhausen's sine tone compositions. And Friedrich Kittler, whose idiosyncratic experiment with a self-engineered acoustic synthesizer is part of the MAF assemblage, shortly before his death, has delivered a lecture under the enigmatic title *Und der Sinus wird weiterschwingen* ("And the sine tone will oscillate forever").

OPERATIVE MEDIA (ART) PRESERVATION

Towards a (re-en)Active Techno-Archive

Media art becomes a literally "archaeological" issue with the challenge of its preservation. Taking for granted the definition that a technical piece is in its "media" state only when being in signal processing, the non-historicist imperative is to keep such works reenactable - either from the original, or by their software emulation. External documentation (by photography, or cinematic recording) does not suffice, since it does not reveal the inner engine which is driving the aesthetic techno*lógos* of works of media art. Artistic technologies here change from subjects to objects of media archaeology.

Preservation of computer-based art is not about the aesthetic content for cultural memory only, but its technological condition of possibility as a cultural value as well. Media-archaeological investigation of early computer art is not nostalgic but has a techno-epistemic cutting edge. While artistic and aesthetic phenomena arising from a piece of media art mostly dissimulate their conditional techno-mathematical processing, "forensic" investigation analyzes the critical techno-logical layers

[183] "Aber vielleicht ist es der tiefere Sinn dieser Erscheinungen, daß das traditonelle Zurechthören gar nicht dem Wesen elektrischer Töne entspricht": Herbert Eimert, Der Sinus-Ton, in: Melos 21 (1954), 168-172 (170)

underneath and the "formal materialism", that is: the structure of its logical circuits and its data formats.[184]

A semantic gap opens when future observers do not understand the interface interaction of a piece of computer art any more. Not only that peripheral storage devices like a CD-ROM do not keep its data intact for a long time; the computing machines themselves will have become outdated and replaced by other systems in faster rhythms. Therefore both operative museums for the continuous (re-)enactment of the electronic hardware, and arctive archives not somply for the documentation of algorithms, but for executable softare, are required.

Preserving the Signal: Media Archaeology in Support of Media Art Preservation

While a specific branch of media-artistic research explicitly investigates the present technological condition, so-called New Media Art as such increasingly becomes the object of media archaeology, when it comes to its own archiving and heritage. Media archaeology, here, is concerned with the challenge of long-time preservation of works of media art itself.

Preservation of media art does not simply require care for the material endurance of the artefact any more, but adaptation to its techno-logical time regime. Preservation of time-based technologies must be processual, as an ongoing act of up-dating the analog or digital art work.[185] Still, a media-archaeological veto insists: To what degree does the hardware of so-called "born-digital" art matter?

That is the moment when media conservation asks for epistemological arguments. It is the primary task of media theory to take philosophical care of technical terms like the "emulation" of early computational media art works by contemporary operating system. What seems evident on a practical level turns out to be a delicate challenge to the ethics of museum preservation. Media archaeology describes the techniques of cultural tradition and develops criteria for a philosophy of dealing with the tempor(e)alities of techno-logical agents. Any piece of media art is subject to time in its hardware embodiment (physical entropy), in its logical, almost time-invariant design (circuit diagrams and software codes), and in its actual time-critical processing. Any epistemology and aesthetics of media art preservation roots its arguments in the

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[184] See Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008

[185] See Bernhard Serexhe (ed.), Konservierung digitaler Kunst: Theorie und Praxis. Das Projekt digital art conservation, Karlsruhe (ZKM) / Vienna (AMBRA) 2013; esp. Jussi Parikka, Maschinenkonservierung - Datenhauerei und die Zeitlichkeit technischer Zeit, 262-275

technological ground, against all seductions of reducing preservation of media art to its shere phenomenological appeal.

There are different museological degrees for media art preservation: conceptual (design), functional (circuitry), and actually operative (time-critical) re-enactment. While in historical re-enactment, the theatrical drama aims at the effect of the original event; *media* theatrical enactment aims at the "functional intactness in archived program software"[186]. In order to keep technologies from the past "contemporary", it is not sufficient to simply display the device like a painting hanging at the museum wall or an ancient sculpture placed in the museum court. An experimental Italian 16mm film like Massimo Bacigalupo's *Quasi una tangente* from 1966 has been re-edited in 2018 for 16mm projection after an intermediate 2k digitization.[187] In a present screening, the 1960s avant-garde will inevitably be perceived as historicized in terms of discourse and context. But on the media-archaeological level, such a technical reenactment, by the high resolution digitization of the noise original, in its rematerialization on celluloid again, allows to co-originally experience such a film now on the same material wavelenght like in 1966. It is the power of the digital sampling theorem that it can emulate the anlog real itself - even if this succeeds for weak human perception only. The applied technological apparatus itself has a more precise spectrographic sense for the world of difference resulting from the aliasing effects in quantizing the signal.

What constitutes the "original" in technological culture is not just its materiality but its processual media-existence. This either requires the provision of operational hardware from the technological past, "or a functional equivalent"[188] - which can be, miraculously, software of a second order, the "emulation" of past hardware in a present Operating System - such as the functional time-adequate simulation of the loading process of computer game data from a cassette tape to a Commodore 64 computer.

Different from the notion of the historical "original" in cultural tradition, the material replica of a media artefact from the past allows for its authentic re-enactment even if the replica is not the original materiality but principally (*en arché*) replaced by a functional equivalent. Only when signal processing, the media-artistic object from the past becomes a "source" of knowledge.[189]

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[186] Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing, vol. 4, no. 3 (1992), 206-210 (209)

[187] By the Archivio Home Movies / Art & Experimental Film, Bologna

[188] Swade 1992: 208

[189] See Christian Sichau, Die Replikationsmethode: Zur Rekonstruktion historischer Experimente, in: P. Heering / F. Rieß / C. Sichau (eds.), Im Labor der Physikgeschichte. Zur Untersuchung historischer Experimentalpraxis,

Media arts preservation is a laboratory in terms of media-cultural heritage, as case studies to ensure future insight into the technological ground of the present media condition, as testimony of a specific techno-cultural epoque. In terms of McLuhan's media theory, preserving artistic content should reveal its underlying technological message which is its true "historical significance"[190]. While in pre-electronic times, the tools of art making, as cultural techniques like painting with brush and oil on canvas, were public knowledge, contemporary media art encapsulates the knowledge of electronics and algorithms.[191]

Preservation strategies for media art require at least two definitions: of "media", and of "art". As expressed by the combinatorial term (instead of a neo-logism), different from traditional art works which have been directly resulting from the performative actions of the human artist, media art unfolds primarily in its technological existence. Different from "re-enactment" of past events in artistic live performance, in criminal forensics or in "experimental archaeology"[192], the re-enactment of media art is by definition operative in the technological sense. Instead of an idiosyncratic corporeal theatrical re-enactment, technological experience of the past in the present is based on the re-operativity of the very machine (the technical configuration) itself.

In 2002, at CCA in Glasgow, Rod Dickinson re-enacted the psychological experiment once conducted by Stanley Milgram in 1961, concentrating on the command of electric shocks for punishment to non-learning subjects in the next room. The "reconstructed" installation can only be called "media" art if the aesthetic message is based on the electric action of a functionally equivalent apparatus with a voltage range from 15 to 450.[193] The cries of pain by the victims in the original scenario were actually communicated from pre-recorded tape already; such recorded presence can be time-shifted without loss of authenticity.

Technologies are "media" only when *in being*, that is: in the moment of signal processing, and media "art" is defined by its time-based modality rather than space-based sculpture and painting. Already in photography,

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Oldenburg 2000, 10-23 (10, note 3)

[190] https://rhizome.org/art/artbase, accessed March 20, 2017

[191] "Als Medienträger sind für uns sowohl die Leinwand als auch die Medienapparate niemals zugänglich." Boris Groys, Unter Verdacht. Eine Phänomenologie der Medien, Carl Hanser Verlag 2000, 21

[192] See Inke Arns / Gabriele Horn (eds.), History will repeat itself. Stragegies of Re-Enactment in contemporary (Media) Art and Performance, Frankfurt / M. (Revolver) 2007, "Foreword" 6 f., and Inke Arns' conceptual introduction "History will repeat itself", ibid., 36-63

[193] Entry "The Milgram Re-enactment", in: Arns / Horn (eds.) 2007: 94 f.; see http://www.roddickinson.net/pages/milgram/project-milgram-video.php

the exposure time has been codefining the iconic subject of the image - a temporal delay (*Delta t*) which increasingly shrinked almost to zero.

Technological media are experienced in performative ways from the human side, but in operative ways from within. In museum display of media art based such as sound and video installations, "[t]he physical objects on display are not to be regarded as aesthetic objects per se [...]. *It is predominantly the process which is on exhibit*".[194] Whatever the aesthetic content may be (to be well documented by a conceptual text by the artist-creator himself), the message of "media art" is its time base and its active chrono-poetics.

Therefore, an art museum necessarily turns into a media theatre for re-operating techno-aesthetics, where the media are the main actors - the agency of the machine, linked with a signal laboratory for re-activating data processing and with a library of audiovisual records or source code content, since any media operativity needs signal food to process. All such processes are grounded in actual media technology - their material key elements (*techné*), and essential in terms of governing principles (electric circuitry diagrams, source code of software).

Against the curatorial veto, infra-structural cables and circuitry in electronic art works - like the agorithms in digital works and the protocols of Internet art - belong to the functional, but not "ideal"[195] aesthetic enunciation, and therefore are allowed to be replaced for re-enactment. The aesthetic content of media art aks to be displayed in action to be revealed; otherwise a medium like a video set is nothing but a piece of metal, glass and rare earths.

Traditional works of art are subject to time in the material sense; it is their physical entropy which requires curatorship and restoration. A painting *endures* in time, different from media-art which unfolds in a different time singularity. A technological object, in addition, is time-based in a conditional sense; their "media" state only reveals when in operation, in signal-processing. The core requirement for the preservation of media art, therefore, is re-enactment, since its being only unfolds as a time-object. This message of media art (apart from the superficial audio or visual content) is temporal, therefore the focus of "preservation" is on actual re-enacment or documentation of its former temporal action, that is: the archival *time diagram*.

Media epistemology contemplates the being-in-time of technological art, and its archaeology grounds in precise technological inspection. There is knowledge to be gained from technical hardware. The media

[194] From the Ars Electronica exhibition catalogue *Eigenwelt der Apparatewelt*, ed. David Dunn, Linz 1992, 20

[195] Julia Meuser, Copyright and the Integrity of the Work in Video Art, in: Kunstmuseum Wolfsburg (ed.), How durable is Video Art?, Wolfsburg 1997, 79

archaeological approach requires in-depth knowledge of the associated technology. For inductive media archaeology, every piece of media art is idiosyncratically different; it deserves artefact-, circuitry- and code-related answers and adaptive tactics rather than an overall strategy of preservation - technological historicism.

The specific way of not simply representing but "re-presencing" media-artistic works from the past requires regenerating and restoring its signal processing. This approach is decidedly materialist and anti-narrative in terms of media discourse. The conditions under which media arts from the past can be said to have "'presence' in the present"[196] are strictly techno-logical.

Operative Media Museology

In 20th century, the familiar agency of the museum has been confronted with the challenge of electronic exhibits. In most museums of technology, for example, television sets of the late 1950 are usually exposed as a "dead" object like any other material artefact. An electronic device that is not processing signals is not in its medium state but just a piece of furniture. Most museum visitors actually look at old television and radio sets like a piece of antiquated design: they recognise the style and maybe become nostalgic about it, but do not attend to it as an operative medium. To exhibit an old TV or video set (like a musical instrument from the past) in action is a challenge for museum conservators when, for example, a couple of condensers have to be exchanged for re-activating their signal processing: Then it is not the original anymore. And when the electronic image is unfolding again, should historical footage from the period of the television be shown, or up to date content?

If the external (protective or decorative) case of a radio from the 1940s is removed in favour of insight into its technological structure, it looks nearly ahistorical. As a technological object it principally works as a radio from much later periods. The electronic tubes (or valves) have been replaced by transistors and microchips in the meantime but functionally it operates in exactly the same way, as amplitude or frequency modulated FM / AM radio. Considered this way, such electronic objects, are structurally not historical at all, they are invariant against temporal change until their infrastructure is replaced by a completely new system, in another temporal rhythm.

In museums of industrial science and technology, one often sees steam engines actually running. But media art which starts with electronic technology is of a different kind; they are not primarily related to energy transformation like industrial machines. What should be displayed in a

[196] Sobchack 2011: 323

museum if the object is electronic media? If the display is reduced to the surface or interface, their essence is missed, but it is difficult for visitors to have a medium opened and understand what is going on within. It is a challenge to museum education and didactics to explain what is really happening *within*, a challenge to the design-orientated, surface-orientated display.

Materiality Matters: Re-Enacting Media Art

It has not been with photography or film, but with electronics that true "media art" as category emerged: electro-acoustic music, and video art. In 1965 Sony's Portapak enabled independent Television art. Contemporary media arts festivals like the Berlin Transmediale and the Ars Electronia in Linz started as video art festivals. The real *arché* of electronic media art is its inherent temporal sonicity, from which the "musicality" of the generic term Fluxus Art as concert-like live event happening is derived, with Nam June Paik's tape-music experiments, and John Cage et al., relating to the volatile, transient character of the acoustic / electronic signal, different from the rather typographic film frame (McLuhan 1964). Paik's legendary *Exposition of Music - Electronic Television* in the Wuppertal Galery Parnaß from 11 to 20 March, 1963 allowed for the distortion of the live television image by magnetic modulation as "participative". Fluxus art emanated from the electro-magnetic field. Such *performative* media art requires co-originary re-operation (rather than arbitrary re-enactment) of the electro-magnetic effect on functionally equivalent machines in its analog idiosyncacies, such as Paik's seminal *Participation TV*.[197]

A film documentation would not tell anything about the conditions which made such appearances possible. Only the preservation of actual electronics allows for re-enactment whose *a priori* radically depends on the analogue electronic tube (it does not work with pixel monitors). Since the electronic image, different from traditional photography, is not fixed, rather a live signal than iconic representation, the criterium for its media art preservation shifts to the oxymoron of material processuality.

Materiality in electronic media does not refer just to hardware. The question that arises is whether, in addition to their value as aesthetical information, media art from the past has an external value linked to the original form of its hardware – which is not sufficiently preserved after its transformation to a digital information carrier. It is not sufficient to migrate the artistic content without saving the original carrier - which would suggest that for an electric video image or a musical tone it is insignificant whether it is recorded on schellack disc, on Compact Disc or as computer file. Whereas for coded, that is: symbolically expressed art

[197] http://www.youtube.com/watch?v=JHC1CdgfkVo

forms like literature the essential enunciation can be migrated via copying alphabetically, the analog signal depends on its material implementation - unless it becomes digitally sampled and thereby ingegrated into the symbolic order which literally transsubstantiates its essence. "The characteristic hiss and crackle of 78 rpm pressings, played by a stell needle, was a part of the listening experience" of a gramophone record.[198] If the material carrier remains transitory, only artistic content becomes the object of preservation. But McLuhan himself insisted, partly in accordance with the communication engineering model, that noise was part of the communication process, pointing at the hidden ground of the apparent technical figure. "What they [Shannon / Weaver] call "noise", I call the *medium* - that is, all the side-effects, all the unintended patterns and changes. [...] all media tend to be subliminal in their structures [...]."[199] But here McLuhan might have expressed more accurately (in comparison to Shannon): the medium *has* a (hidden) message.

Media-active archaeology is anachronistic in many ways, when it comes to the restoration, e. g., of original recordings from the dawn of television technology, made in the era of mechanically-scanned television. "Not until the computer era came on us could we study these images"[200] by means of algorithmic signal detection and filtering software. An ironic echo is the *VinylVideo* project, which Gerhard Sengmüller calls a "piece of faked media archaeology"[201].

Media archaeology does not bury technological events by contextualizing them in historical narratives but helps for media devices to let it "speak for itself". As enunciative media archaeography, it focuses on essential, knowable epistemogenic sections which normally escape human interface perception (like the "racing" of the beam in early computing games, or the "latency" image in iconoscopic television) - a plea for "material semantics" without reductive materialism. The access to the archive is no bureaucratic decision any more but requires proper technologies and algorithms for signal re-play - which makes all the difference between traditional arts and genuine electronic media art. The internal value of all electronic technology lies in its configuration and circuitry, in its interlacing of aesthetic appeal and material form of

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[198] Ray Edmondson, AV archiving philosophy - the technical dimension, in: Proceedings of the IAMI-IASA Joint Anjual Conference, Perugia 1996, no. 8 (November 1996), 28-35. On artistic abuses and extensions of media technology, see Caleb Kelly, Cracked Media: the sound of malfunction, Cambridge, Mass. / London (MIT Press) 2009

[199] National Archives (Canada), H. M. McLuhan Papers, H. M. McLuhan to Jerry Agel, 26 March 1976

[200] Donald McLean, http://www.tvdawn.com/index.htm; accessed 15 March, 2008

[201] visomat inc., asciiVision, in: Thomas Y. Levin, Ursula Frohne / Peter Weibel (eds.), CTRL[SPACE]. Rhetorics of Surveillance from Bentham to Big Brother, Cambridge, Mass. (MIT) / Karlsruhe (ZKM) 2002, 372

transmission. To reveal this implicit knowledge is a cultural value in itself and therefore belongs to the tasks of media art preservation in museums. Digital signal processing (DSP), with which one can simulate analogue sounds and images, up to and including interference, acoustic noise, and virtual reconstruction of the original performance space, is an example of the ambivalence between physical carrier and aesthetic content. Here, as in works of audiovisual media art, the performative (better: operative) behavior of time-based media art works becomes the decisive criterion in the analysis. For this reason, processual "re-presencing" (Vivian Sobchack) is a key operation in media-art archaeology. In the case of the video tape, the storage medium itself moves, while current flash memory in computers stands still and data movement becomes a function of programming. The obvious materiality of electronic analog media enters the space of the calculating media by means of the simulation, for example, of a magnet tape video installation as a time event in a computer. The sampling theorem allows for the digital to recreate the analog signal.

Preserving Signals as Data

The imperative for museological preservation of digital media art is to lay bare not only the abstract underlying algorithms, but their concrete implementation in circuitry. This techno-anatomy reveals the *arché* of the technological *l'archive* in Foucault's, not in the memory institutional sense, the "submedial space" (Boris Groys) behind the screen or other kinds of interface.

[Fig.: Media-archaeological “excavation” and subsequent re-processing of one of the earliest relics from cybernetic media art (New Tendencies, Zagreb): Vladimir Bonačić's “Dynamic Object” no. GF.E16S (1969), a random number generator (Galois Field) for light patterns. Photo: Miro Cimerman]

The Electronic Records Program at the National Archives and Records Administration in the U. S. offers a model for defining digital (art) objects on three levels: its physical embodiment (such as magnetic charges on tape), its logical existence (formats in software), and its conceptual existence which refers to the phenomenon appearing at the machine-human interface.[202] Kirschenbaum analytically separates forensic (hardware) and formal (software) materiality while admitting its increasing interlacing.[203] An EEPROM, for example, is an electrically

[202] Kenneth Thibodeau, Overview of Technological Approaches to Digital Preservation and Challenges in the Coming Years, in: The State of Digital Preservation. An International Perspective, Concil on Library and Information Resourses, pub107 (2002), http://www.clir.org/pubs/reports/pub107/thibodeau.html

[203] Matthew Kirschenbaum, Mechanisms. New Media and the Forensic

erasable programmable read-only memory. The climax of this oxymoronic blurring is the software emulation of previous computer hardware itself.

Materiality is still the blind spot of the information age and in electronic media. Digital media provide for materiality only by means of the 3-D printer, transforming the information of the object into its material replica. But a media artistic object has more information in it than a recording or scanning would ever provide. If the "aura" appeal of a work of art is rooted in its uique quality of being here and now[204], it is dependent on its material presence which is lost in reproduction.

Ephemeral media (art), though, is process-oriented; thereby it undermines the traditional evaluation of the museum object in its principal claim for long-time endurance. There is a conscious transformation in the temporal economy of cultural value. The advantages of "new" media usage, like online access to the Internet and computer software, opens more immediacy and creative possibilities than ever but for the price of almost immediate obsolescence. Media artists since Fluxus Art times have been conscious of this time-critical contract (creative processuality vs. museal endurance); from that derives that the preservational imperative itself diminuishes into an extended present.

Analog signal recording media like phonographic, magnetophonic and video image recordings are subject to entropic ageing; they degrade over time and quality with every copy they (re-)produce, and in themselves. But once the signal has been digitized, it becomes ideally "timeless". Digital information - even if actual computing takes place in energy-absorbing, thereby temporally irriversible machine systems - is conceptually suspended from physical time in information theory. The present as temporal denominator looses its plausibility with the *binary information digit*.

The Videodisc, as the technological scene (or condition) of a couple of early media art works, in close reading looks digital, but it is analog video signals which are recorded discretely, different from the Audio Compact Disc which actually stores binary information, not the acoustic signal itself (like the phonographic record). Finally the CCD (charge-coupled device) camera, with its frame-transfer system, transforms the electronic image into data blocks.

With the digitalized preservation of analogue media art heritage, the data file becomes a complete substitute of the original image relating to

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Imagination, Cambridge, MA (The MIT Press) 2008 111

[204] As defined in Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit [*1936], Frankfurt / M. (Suhrkamp) 1969, 14

the visual content. This epistemological dilemma changes when it comes to "born-digital" media art. The American Standard Code for Information Interchange (ASCII) has been based on a seven bit structure, which in early days of computing was used for transmitting photos and graphics as well by elementarizing (if not pixelling) the visual information and translating it into the available 128 characters. Different art projects like *ascii Vision* in the works of the *ascii-art-ensemble* refer to this digital Stone Age.[205]

The media archaeological approach to the preservation of (digital) media art focuses on the conditions of possiblity of such techno-aesthetic expressions, not exclusively the surface appearance (the aesthetic "content") which is figuratively exposed. The inherent quality of a technological work of art is not addressed to human senses only. In works of ASCII art, the hidden media message ("ground", in McLuhan's sense) is expressed by the work of art itself.

There have been moments when the hidden technological ground expresses itself, like the Williams-Kilburn Cathode Ray Tube memory in early electronic computing from 1947. Each phosphor charge, on and off on the screen, not only represented but embodied a binary "zero" or "one". This is not video art but functional electronic imaging. Since the charge would decay within 0,2 seconds, a detector was placed in front of the CRT, obstructing human insight, allowing for an electronic beam again to refresh the charge just in time to keep it. In such technology, the Cathode Ray Tube was actually used as a storage device for a number of bits - thereby revealing the medium message on the "interface" itself, in an act of almost media artistic engineering. But the only audience to observe this display was meant to be the computer.[206]

The "Two Bodies" of Computer-Based Art

For the preservation and legacy of signal-based (analogue) and (computational) works of new media art, a secure storage environment for media-artistic data, in digital preservation, is achieved by generating checksums for files which are monitored by re-checking, on a regular basis, in order to identify any changes to files - be it corruption, loss of data, or unintended manipulation. "This could mean creating checksums as you export a file from the hard drive on which an artwork was received, or as soon as you have exported a file from an editing program

[205] visomat inc., asciiVision, in: Thomas Y. Levin, Ursula Frohne / Peter Weibel (eds.), CTRL[SPACE]. Rhetorics of Surveillance from Bentham to Big Brother, Cambridge, Mass. (MIT) / Karlsruhe (ZKM) 2002, 372

[206] See David Link, There Must Be an Angel. On the Beginnings of the Arithmetics of Rays, in: Siegfried Zielinski / idem. (eds.), Variantology 2. On Deep Time Relations of Arts, Sciences and Technologies, Cologne (Walther König) 2006, 15-42

or after digitizing a tape."[207]

Different from previous technologies, the computer as *turingmachine* is a theory-born medium. Still, a symbolical machine (equalling the algorithm, according to Turing 1937), in order to become operative in time, needs to be implemented in the physical world, i. e. in time. While its main quality is software, such code needs to be implemented in actual and active matter. A museological gap opens between material preservation and functional re-enactment, especially in preserving computer art.

Regarding his early computer graphics, Georg Nees insisted that they were *not* works of art but models for works of art. "They belonged to the domain of aesthetics, but to a different category than that of art that requires a human imperative."[208] Therefore, "computer arts" is a hybrid term. Programming differs from making a sculptural or painterly art object; code does not violently manipulate raw physical matter but cybernetically decides *re-configurable* electro-physical hardware).

When a present computer emulates a previous Commodore 64 in order to run a vintage video game, it functionally (not historically) *is* in the C64 *present* state. The concept of emulating another machine is essential for the very definition of the Universal Turing Machine: Once a mechanism has been transcribed into a discrete sequence of states, it can be initially inscribed onto the "register", that is the tape of the TM.[209] A Universal Turing Machine can emulate any other specific Turing machine, by defining its sets of program states and writing it as data symbols on the tape. "Being remarkably similar to the Von Neumann model of a computer, where both programs and data can be stored on the same medium [...] it follows that a UTM could emulate itself."[210] Although the TM is construct in mathematical theory rather than a physical computer, it therefore ultimately leads to the material 3D printer.

That makes computer-generated art different from previous analog media works. At the same time, in the background the contemporary operating system is running; therefore the emulated computer is in both a historical and a trans-historical state. 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

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[207] http://mattersinmediaart.org/sustaining-your-collection.html

[208] As quoted in: Paul Brown / Charlie Gere / Nicholas Lambert / Catherine Mason (eds.), White Heat Cold Logic: British Computer Art 1960 - 1980, Cambridge, MA (MIT Press) 2009, 86

[209] Alan M. Turing, On Computable Numbers, with an Application to the Entscheidungsproblem, in: Proceedings of the London Mathematical Society (2) vol. 42 (1937), chap. 6

[210] Mike DeHaan, The Universal Turing Machine is a Turing Machine Emulator; https://www.decodedscience.org/what-is-universal-turing-machine/12081 accessed February 9, 2017

the temporal dimension functional emulation (the matahistorical realm of techno-mathematical logic) becomes "high fidelity" in terms of micro-temporal behaviour. So-called "Retro Computing" resembles what is known as *reverse engineering*. It liberates the primary artefact, the C64 computer, from its total historisation and musealisation, and rather identifies the time-tunneling immediacy of its operational being.

Even if most of digital computing is embedded in a body of integrated electronic circuitry, what (literally) "counts" in actual computing is not only the materiality but its algorithmicized logic. What the symbolic order of culture distinguished for a long time as *physis* can now be negotiated alphanumerically as information. The re-presentation of seminal works of digital media art in particular is enabled by functional emulation; at the moment of the configuration this concerns not a historical citation, the invocation of a chapter in digital art history, instead the new computer *is* in the state of the old. The category of the “historicity” of media art may therefore be reconsidered.

A conflict arises between preserving material hardware and preserving software, with an emphasis on the concept of "emulation" as preservation strategy. Emulation as different ontology is inherent already to the character of the Turing machine, different from electro-material-only artefacts.

The Different Quality of Computational Media Art Preservation

G. E. Lessing's *Laocoon* theorem from 1766 defines the medium-specificity for different art forms such as literal poetry and visual painting. For analogue media art, this refers to the electronic technologies which are the pre-condition for any subsequent specific aesthetic effect. Behind the phenomenal appeal, the essential *message* of such media works derives from the conditioning hardware and circuitry which have become co-authors of the artistic production.

With computational art, though, previous media art differences are not rooted in their brute materialities any more but have become formats within the software regime. Source code on the one hand (algorithms), and the formating frameworks (operation systems, browsers et al.) are the core "engine" of New Media art. From that derives the option of "emulation" for re-creating (rather than passively archiving) a work of code art even if its original software environment has become obsolete.[211] Computational art exists in "turing time" (Friedrich Kittler) which fundamentally differs from the historicist temporal order which has concerned media (art) preservation so far.

[211] For the "logical replication" of obsolete computing machinery (case Charles Babbage's Difference Engine No. 2), see Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing, vol. 4, no. 3 (1992), 206-210

The philosophy of media art preservation therefore is symptomatic of the challenge in media-cultural heritage itself, beyond the museum works in the more limited sense. Media art can be evaluated on the basis of its technical properties which are subject to temporal ageing. But with digital media, there is an additional logical level of techno/logies involved which is negentropic in principle.

The digital sublime (to make use of a Kant's and Burke's category for an-aesthetic sensation) has become the core experience of "virtual" space. While the binary and algorithmic features of computational art works are not what humans perceive in their interface encounter with the machine it is the more urgent to remind of the material aspect of computerized data. Technological economics is still fundamental in both the design of computer hardware and software.

The challenge of algorithmic art preservation may be compared to the musical score. Performative media art only exists in actual operative realizations; the Berlin Computer Games Museum has developed experience in preserving such interfacial situations for interactive ludic media. Alternative to a focus on the phenomenological appearance of ephemeral media art installations is the epistemological focus on the knowledge which is embedded within the machines, which is revealed by a specific work of media art, as process-oriented ontology. Terms like "emulation" are not just functional in the context of media art preseration but deserve unfolding their epistemic delicacy in terms of object-oriented ontology.

With a Sense of Ending Already: The Ephemerality of Internet Art

The qualities of new media art are neither exclusively reducible to material, nor to its software tools. Rather, new media art is process-based practice with limited duration, as it has been envisioned by the electro-acoustic and video works by the Fluxus art movement in the 1960s and 70s already which has a conceptual sense of ending built-in already. Documenting dynamic media art (be it site-specific installations or Internet art) is one task; preserving and re-enacting the interactive experience is another one, such as the "webrecorder" (provided by Rhizome, New York) as free software allows for. A gap opens between the phenomenal appeal and its intra-structural technical condition. Taking into account audience participation and (web-)site-specificity, it becomes clear that for processual media art works there is no such original state at any given moment from the phenomenological perspective. The technological conditions for such interactivity itself, though, on the contrary, are not allowed to change within the artwork from moment to moment, even if *in-situ* conditions mean that the installation must constantly adapt to new circumstances.

For dynamic media art preservation, the ephemeral phenomenal visitor or user experience is not the only cultural value worth to be preserved. While for the inaugural exhibition event, priority is on the affective experience and human-machine communication ("media art"), what becomes more interesting for future memory of past artistic research knowledge is the testimony of its technological ground ("medium art") as implicit knowledge for which the interfacial, phenomenal appeal has been rather a symptom. Central for the preservation of Internet art is the algorithms and microprocessing electronic units which run digital media formats and compression - the real *l'archive* as precondition of media art action in terms of Foucault's *Archéologie de Savoir* (1969). A radical museology of "new" media art reveals computing architecture from within instead of surface display. Here, the logic of enunciation in fact corresponds with machinically implemented logics, to be expressed in algebraic formulas and program code. The notion of "logical preservation", as it has been developed in documentary science[212], thereby extends to the media-active, archaeological preservation of a continuously represencable techno-aesthetic past.

Media culture is not only challenged by the imminent and speedy obscolecence of artworks which are based on, or within, forms of the World Wide Web, but the Internet might end itself, in two ways: a) in terms of accessability (the "archive"), with an increasing privatization and of the former "public domain" into commercial sectors[213], and b) in terms of its techno-logical intrastructure. The glass fiber cables (the physical "medium" of the Web) will crack, and the protocols be hacked. Will the Web be a "dead medium" (in Bruce Sterling's sense) soon? Media archaeology is both a method of academic inquiry, and an aesthetics, to make users more familiar with such temporal "laws of media" and their museification. The anticipation of the end (such as the possibility of a collapse of the Web, and the imagination of a "web after-world"[214]) is no mere figure in the philolosphy of history, or literary fiction, any more, but has become a current technological practice, ranging from the *futurum exactum* in the cybernetic sense (Norbert Wiener) to predictive coding in contemporary data analytics.

The MAPS 2020 conference "Dead Web" focuses on the obscolecence of Internet and Web based artworks. From a Classicist perspective, the question arises: How did artworks from antiquity survice into the present? It is the resistance of hardware (statues from marble) which insisted material corruption which entropically attacked other matter, and ends in private and public museum collections. The conference

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[212] Hans-Joergen Marker, Data Conservation at a Traditional Data Archive, in: Edward Higgs (ed.), History and Electronic Artefacts, Oxford (Clarendon Press) 1998, 294-303 (296)

[213] For an early discussion of that challenge, see Jean-François Lyotard, The Postmodern Condition. A Report on Knowledge [*Paris 1979], Minneapolis (Univ. of Minnesota Pr.) 1984

[214] As indicated in the subtitle "Dead Web" of the MAPS 2020 conference (and exhibition) on Media Art Preservation at the Ludwig Museum / Museum of Contemporary Art in Budapest, February 13 / 14, 2020

focuses on the obscolecence of Internet and Web based artworks - with some of them actually reflecting upon their own ephemerality, such as the seminal JODY website.[215]

The main question "Will the Internet end soon?", when understood in its temporal, rather than topological, spatial sense, reminds of the "Internet" already naming its intermediary status, as an "in between" in the core sense of the technical medium as channel of transmission - the Aristotelean *to metaxy*.

The media-archaeological anticipation of the possible breakdown of the Internet, as *futurum exactum*, reminds of its very beginning (*arché*), since it started with an erroneous transmission in the first text communication ever sent over the data lines of ARPANET, between the host computers at the University of California in Los Angeles, and the Stanford Research Institute on October 29, 1969. The medium itself has been the message, in the sense of an excess of techno*lógos* , since the transmission itself was literally to *log* in. "They succeeded in transmitting the 'l' and the 'o' and the the system crashed!"[216] To bring the operation in being, it required a full "login" an hour later, as has been appropriately recorded in the UCLA *IMP Log* as "talk" (Ibid.).

Media archaeology is accustomed to the obsolescence of pre-Internet media systems like global telegraphy, or analog radio and television broadcasting. "Radio", on the other hand, sublimely survived - not as a public broadcast format for radio and television programs, but as electromagnetic infrastructure for wireless data transmission (e. g. W-LAN, and mobile communication devices).

The breakdown of the Web (the *Empire*, in the sense of Hardt / Negri) might be compared with the fall of the Roman Empire which basically was a collapse of its logistical infrastructure: military roads, and the postal system.[217] The very Latin term *imperium* does not refer to a territory, but to a logistical extension: how far the power of commandment by the heads of state *extends*. The technical infrastructure, therefore, is not simply the instrumental precondition of

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[215] See Alexander Galloway, Protocol. How Control Exists after Decentralization, Cambridge, Mass. / London (MIT) 2004

[216] Leonard Kleinrock, The Day the Infant Internet Uttered its First Words [2019]. Available online: https://www.lk.cs.ucla.edu/internet_first_words.html (accessed 4 November 2019). See Peter Krapp, The Error at the End of the Internet, forthcoming in: Maria Korolkova / Timothy Barker (eds.), Miscommunication: Errors, Mistakes, and the Media, London et al. (Bloomsbury Academic)

[217] See Bernhard Siegert, Der Zusammenbruch des römischen Reiches, in: Hans Ulrich Gumbrecht / K. Ludwig Pfeifer (eds.), Paradoxien, Dissonanzen, Zusammenbrüche. Situationen offener Epistemologie, Frankfurt / M. (Suhrkamp) 1991

an empire, but infrastructure *is* empire. Such kind of extensions have an either a spatial (in the geographical sense), or a temporal (tradition) "bias", as it has been explained in detail, for several successive cultural regimes in occidental and oriental history, by the forefather of McLuhan's Media Studies, Harold Innis.[218] Innis' analysis *Empire and Communications*, published 1959, though stopped with the broadcast media of his day (radio, extended to television by McLuhan) - a system which has been (topo-)logically (if not electrophysically) been replaced by the ("Inter")net paradigm. It is this interconnective trading and communication topology - the "Carthage option"[219] as an alternative to the imperial territory - which links Carthage to the World Wide Web, different from the conventional military empire. "The paradox that Innis would have to face today is that telematic media represent, at a technical level, both poles: ease of transport and durability. Media transmission around the world can be, in effect, almost instantaneous [...]. Similarly, data burned into refined variants of sand can last, in effect, forever, so there is no more fragility of media-in-time to overcome."[220] Against this aionic optimism,

Media archaeology learns from the proper discipline of archaeology here, studying what remains after a territorial empire on the one hand, and a trading network, has collapsed. Roman monuments endure across milennia, while the traces of Carthagenean trading, with its intermediary storage (staples), have disappeared already with their functional economy. In a literal understanding of technology (rather than simply "technique"), this refers to the material ("monumental" hardware), and the symbolical ("code") regime; the World Wide Web, after all, has been first of all a function of its Internet protocol ("http"). The Internet itself, though, came out as Paul Baran's de-centralizing of electronic communication chains against the thread of a deadly attack on the former center of control. Will such an infrastructure, in parts, still endure, or prefigure, and structure, successive territories - just like the road system of the Roman empire prefigured future motorways in Italy, or the alphabetic code of ancient Greek and Roman knowledge, through tiny channels of tradition (medieval monasteries), survived the "dark ages" until its literal "renaissance"? Will hardware become isolated monuments, when the circuitry of its interconnections has been ruined, or will the cables simply the redefined, such as the early ARPANET did not disseminate an independent grid of cables between computer centers, but used the "analog" telephone lines for "digital" data transmission (the

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[218] See Harold Innis, The Bias of Communication, Toronto (University of Toronto Press) 1982

[219] See David Godfrey's "Afterword" to Harold Innis, Empire and Communications [*1950], Victoria / Toronto (Press Porcépic) 1986, 171-178; further W. E., Karthago (gegen den Romazentrismus), in: Armin Adam / Martin Stingelin (eds.), Übertragung und Gesetz. Gründungsmythen, Kriegstheater und Unterwerfungsstrategien von Institutionen, Berlin (Akademie) 1995, 177-190

[220] Godfrey 1986: 171

TELNET)? Will the "Web" gently transform into another technological being, such as the declaration of an autonomous "sober net" in Russia (November 2019)? Will a declaration of independence be restricted to the symbolical order of transfer protocols and IP addresses, or extend to the electrophysics of the cable grid?[221] And concerning its event temporality: Will the Internet slowly evolve and transform into something else, by increasing economical segmentation, or by the delimiting interference of the nation-state (such as in the case of the Russian corporation Yandex with its Internet-related services such as its Russian-language specific search engine, and mobile applications)? To what degree does the non-technical, adminstrative political symbolic order interfere with the techno-symbolic order of Internet protocols and its material infrastructure?

Or will the Internet be dis-continued abruptly, by external factors like a) a breakdown of electric energy supply, b) a shortage of material resources ("rare earths"), or c) a hacking of its logistical data protocols (the "code")?

"Historical" media archaeology is an exercise in *futurum exactum*. To look at the present (media) condition with the eyes of a future archaeologist has a long tradition in occidental aesthetics of cultural time already, such as the "ruin phantasies" in the Classic and Romantic painting and gardening tradition. In the late eighteenth century, a painting by Panini's envisioned the Musée du Louvre already as a future ruin, and Sir John Soane's Museum in London, in the early nineteenth century, has been actually designed with respect to its aesthetics as *futurum exactum*. In his manuscript *Crude Hints Towards an History of my House in Lincoln's Inn Fields*[222], Soane imagines the confusion the remains of his house-museum will arise to future archaeologists - like Albert Speer's "ruin theory" for the architectural appearance of his monumental buildings after the end of the "1000 years Reich".[223] But the rigid media-archaeological caution, at that moment, is to resist the allure of allegorizing media systems, in favour of its infrastructural grounding *as* technology.

The challenges of long-term preservation of Internet art has been an issue in the archival, curatorial and museum field already[224] - including the necessity of a repository like GitHub for preserving the source code behind all the software which is involved.[225] But the anticipation of "The

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[221] See Daniel Gethmann / Florian Sprenger (eds.), Die Enden des Kabels. Kleine Mediengeschichte der Übertragung, Berlin (Kulturverlag Kadmos) 2014

[222] Now published in print, with an introduction by Helen Dorey, by Archaeopress, Oxford 2015.

[223] See W. E., Historismus im Verzug. Museale Antike(n)rezeption im britischen Neoklassizismus (und jenseits), Hagen (Margit Rottmann Medienverlag) 1992

[224] See, e. g., the workshop *Kultur-Back-Up* at Hochschule Mainz, Germany, October 29 / 30, 2019, http://vangoghtv.hs-mainz.de/?page_id=589

[225] See Friedrich Kittler, Museums on the Digital Frontier, in: Thomas Keenan

Dead Web" goes beyond. In the Molior exhibition project[226], this imagination is immediately coupled to the temporal rhetoric of "the end". *Il senso della fine*, though, means not only finitude, but fulfillment, and post-historical endurance, as well (in Hegel's sense of "the end of art"). Will the end of the Web be a sudden break-down, a traumatic irruption of the real by an electronic bombing, as catastrophe like the end of antiquity, or a subtle transformation like early modernity against the late Medieval age?

What will survive from the Web, and in what form? The technologies of tradition split into the material real (hardware), and the symbolic order (code), that is: "a space-time henceforth to be shared between digital and physical realities" (Molior ibid.). The physical layer at the base of the OSI model knows "no software"[227] at all.

Foucault's prophecy, articulated in the final paragraph of his archaeology of human thought, may recur from within Internet technology itself. Like "man", the Internet is an invention of recent date as well. "And one perhaps nearing its end. If those arrangements were to disappear as they appeared, if some event of which we can at the moment do no more than sense the possibility – without knowing either what its form will be or what it promises – were to cause them to crumble, as the ground of Classical thought did, at the end of the eighteenth century, then one can certainly wager that man would be erased, like a face drawn in sand at the edge of the sea"[228] - like from silicon, which is literally the material basis of the Internet.

ARTWORK / DOCUMENT IN TIMES OF TECHNICAL SIGNAL PROCESSING. A Media-Archaeological Analysis

The relation between media artwork and its documentation, in the exhibition context, might be understood not in a historicist sense, that is: as belated or retrospective archiving, but in terms of a creative co-presence. "Technical reports" shall reveal the operational conditions of the actual artwork already on display - corresponding with Michel Foucault's concept of *l'archive* in his *Archaeology of Knowledge* (1969).

(ed.), The End(s) of the Museum, Barcelona (Fondació Antoni Tápies) 1996, 67-80

[226] The Dead Web - La Fin, curated by Nathalie Bachand; see www.molior.ca/en/projets/the-dead-web-la-fin-available-for-circulation, accessed 23 October, 2019

[227] Friedrich A. Kittler, There is No Software, in: idem, Literature, Media, Information Systems, edited and introduced by John Johnston, Amsterdam (Overseas Publishers Association) 1997, 147-155

[228] Michel Foucault, The Order of Things. An Archaeology of the Human Sciences [FO 1966], Oxford / New York (Routledge) 1989, 422

"Documentation"of artwork, and the difference media art makes

In the terminology of documentary science[229], *documents* primarily refer to the *written*, textual record concerning the record archives, while the material *monument* relates to the artefact and the museum. Contextual documentation usually remains exterior to the artwork itself.

For electronic or digital works of art, though, media-*archivo*logical analysis is required, since its "documentary" aspect is inscribed in the artwork already: such as the algorithmic source codes a.k.a. "software", or the circuit diagram of its hardware electronics.

For media artworks, the human and the machine "documentation" fall apart. This corresponds with two different cultures of archival record management: historical "provenance" of an administrative process vs. functional "pertinence", ordered according to structural matter.

Terminology should be clear at that point. Artwork which makes use of standardized hardware - such as most photographic art - will not be called "media art" here, since its technical "ground" (to use terminology from the *gestalt* theory) is most frequently hidden against the phenomenal semantic "figure". This has been discussed by Clement Greenberg[230] in an art-critical update of G. E. Lessing's 1766 *Laocoön* theorem[231] and subsequently developed further by Marshall McLuhan into a theory of *Understanding Media*: Only when the material, or technical, medium, in its *medium-specificity*, becomes the aesthetic message, the term "media art" is justified.

In similar terms, Joseph Kosuth's manifesto of conceptual art[232] turned away attention from the aesthetic content of an artwork to the conscious exposure of its very medium message, in resonance with Greenberg's vision of modern painting.

It usually is the incubation phase of a new medium when its technical nature itself is subject of artistic "media-archaeological" experimentation.

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[229] See Paul Otlet, Traite de Documentation. Le Livre sur le Livre. Theorie et Pratique, Bruxelles (Mundaneum) 1934

[230] Clement Greenberg, Towards a New Laocoon, in: Partisan Review Bd. VII, Nr. 4 (1940), 296-310

[231] Gotthold E. Lessing, *Laocoön. An essay on the Limits of Painting and Poetry* [1766], transl. by Edward Allen McCormick, New York (Bobbs-Merrill) 1984

[232] Joseph Kosuth, Art after Philosophy (1969), reprinted in: Peter Osborne, Conceptual Art: Themes and Movements, London (Phaidon Press) 2002. See as well Art & Language, Introduction, in: Art-Language. The Journal of conceptual art (1969), reprinted in Osborne (2002)

The media art-critical focus is therefore on the inner-technological aesthetics rather than on its surface.

The difference between "technical" and "technological" media art should be clarified in that context. The photographic and cinematographic apparatus are mechanical automatisms, while computer-based digitally coded or even "generative" artworks are, by necessity, techno-logical. Their hybrid techno*lógos* is rooted in both its materiality *and* in its symbolical coding.

The quest for a co-present - rather than just belated, subsequent - "documentation" of media artwork derives from the technologization of art after its production switched from directly body-related cultural techniques (such as sculpture and painting) to genuinely technological "mediation" of aesthetics in the early 20th century. Since then, the mechanism, and then its circuitry and code, became decisive for the art work to come to existence at all but has been usually been concealed in a "black box". Starting with the photographic apparatus in mid 19th century, and escalating in cinematography, hardware already has been "pro-grammed"[233] to a degree which cannot be separated from the resulting work aesthetics and therefore requires *contemporary* documentation for art-critical transparency.

Contextual metadata, in their archival sense, usually remain exterior to the material artwork such as a painting. This is radically different from technical imaging and its compression codecs like MP3, where its "meta"data can be derived from within the digital image itself. A digitial image can alternatively be represented, on the same computer screen, in its informational essence by its hexadecimal representation as alphanumerical matrix of pixel values. An example is a digitized photograph of Barraud painting the notorious dog Nipper listening to his master's voice from grammophone.

In a hex dump, each byte (8 bits) is represented as a two-digit hexadecimal number.[234] "Looking at a hex dump of data is usually done in the context of either debugging, reverse engineering or digital forensics.

This results in a different form of art criticism. While for classical artworks, their creative idiosyncrasies can well be biographically documented and narrated, media art is co-authored by the machine, which - close to the radical "material analysis" approach developed by art historian Monika Wagner - requires a techno-logical report. Matter *plus* logics are only documentable in non-narrative ways.

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[233] Vilém Flusser, Für eine Philosophie der Fotografie [*1983], Göttingen (European Photography) 1989; translation into English: xxx

[234] https://en.wikipedia.org/wiki/Hex_dump#cite_ref-1, accessed March 7, 2023

It is the techno*lógos* of the machine which requires documentation here. With media art in the well-defined sense, the intermediating technology makes it mandatory to articulate its co-authorship from within: the diagram of hardware circuitry, the symbolic code, and finally the mathematical models in case of AI-generated artwork.

Artistic creation, in media art, is a hybrid of human performance and operative technical action - whose *a priori*, in its autonomy from the human, deserves its own explicit technical report.

Most media artists, though, tend to dissimulate the techno-logical bias (such electronic sensors, A / D converters, software) in favour of the immediate phenomenal audio-visual effect on humans.[235]

In the artworks from the pre-technological past, the material basis of the form remains mostly visible to the observer (such as the marble of sculpture, or the canvas and oil in painting), while in media art, the actual art "at work" (signal and data processing) recedes into the hidden layers of the apparatus. Such a "black box" is diachronical as well: usually the exhibition and display of media art works shows only the final result, not its genealogy, its becoming. For media artwork, the critical imperative of opening the black box therefore coincides with "instant documentation" in real-time.

Most installations of media artworks tend to hide its generative mechanisms, and its cables and electric power supply, behind the effects of the screen projections. Computer art protagonist Frieder Nake, though, reminds of the twofold existence of technical *imaging* between the human-oriented machine interface as the actual scene of media perception, and the hidden "subface" within the computational machine.[236] This can be illustrated by two aspects of a vintage computer game as vector graphical monitor on the one side, and its actual circuitry on the other side.

In media artwork, the techno*lógos* of the (computational) machine is co-emerging with any artistic intention and audio-visual "content".

For electronic and digital art, the technological record is part of the artistic practice from the beginning (*en arché*) - not simply after the creation for belated archival documentation. Here, the split meaning of the very term "archive" opens: in the Foucauldean sense of *l'archive* as a material and digrammatic *a priori* on the one hand, and in the

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[235] Such as Tim Otto Roth's *Astroparticle Immersive Synthesizer³* (AIS³), installed in September, 2018, at St. Elisabeth church, Berlin

[236] Frieder Nake, Das doppelte Bild, in: Bildwelten des Wissens. Kunsthistorisches Jahrbuch für Bildkritik, vol. 3, no. 3 (2005), 40-50

institutional sense of the administrative record office (*archives*) on the other.

For works of media art, from the beginning (*an arché*), there is an apparent indifferentiation between artworks and documentation. The implementation of the symbolic code into the computational machine is at same time its operational documentation from within already, whereas between the non-programmable artwork and its documentation by textual metadata a gap opens, an epistemic dichtomy between matter and alphabetic symbols.

Concerning "documentation", works of "media art" radically differ from traditional art. What is labelled "artwork" is still a cultural technique, whereas media art has a logics of its own. What emerges from the code (software) as well as from its material machine condition (hardware) in so-called media art (which in itself divides into electronically "analog" signal transduction and "digital" data processing) therefore requires a different kind of technical report, far away from the current "documentation fever". While the fields of conventional cultural aesthetics and its institutions like archives and museums are more concerned with external documentation of artworks, media science investigates technology-based artwork from within.

The relation between document(ation) and artwork changes in / as media art, when the document becomes inherent to the art work itself. Circuit diagrams and code are no external "documents" of media artworks, but the very condition to the physical implementation of such works. The relation between the symbolic document (the algorithm) and the material "implementation" of the media artwork becomes an entanglement.

This concerns the formal "archivization" vs. "musealization" of media art as well which can neither be reduced to the preservation of its hard- nor to its software: any "documentation" of digital artwork requires both regimes, since only when actually reenacted, the algorithmic "score" becomes matter & energy as "algorhyhtm"[237].

An essay by Paul Valery from the 1930s addresses the challenge of how to exhibit mathematics in museums. To "reveal" (rather than simply to *document*) both the hard- and software condition of media artworks is a similarly difficult task. Electronic art (circuit diagram) and computational art (code) require co-present documentation in the exhibition or museum space, since here "documentation" is not only a question of archival

[237] Shintaro Miyazaki, Algorhythmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012; http://computationalculture.net/algorhythmics-understanding-micro-temporality-in-computational-cultures

retrospective, but mandatory for an understanding of its underlying processes, with the machine being the co-author of the media artwork.

This requires a kind of "preemtive" documentation - an "archive" rather in the active Foucauldean sense of "imperative" programming languages of computing prescribing the present, not just "documenting" it afterwards. The archive is not "after" the artwork here, but actually precedes it.

Terminology may become antiquated here. The "document" is a term from documentary science, such as, in archival science, the "record".[238] But for media artworks, documentation is not simply peripheral; it rather raises the question of the *parergon* in Kant's and Derrida's sense: Does the documentary enframing belong to the artwork itself?

(Post-)Conceptual art, and the technical diagram

The postulation for an instant media-archivological co-documentation of any kind of artistic installation derives from its technology-based essence: Media artworks are in principle (*en arché*) in accordance with what is labelled as "conceptual art". The term conceptual art occurred with the primary emergence of "media art"

With computer processing, the art object became flexible to a degree which transcends even signal manipulation in Fluxus video art. That algorithmic plasticity, coupled with cultural semiotics, has resulted in the post-conceptual art object which - as software - is "immaterial" when compared with classical sculpture or painting. Its materiality has not vanished[239] but shifted to a different kind of matter: its electronic computer mother board.

With conceptual art, the diagrams of the work "take precedence over traditional aesthetic, technical, and material concerns"[240]. In Charles S. Peirce's sense of diagrammatic iconicity, which ranges from algebraic formulas over logical circuits to work flow diagrams, and in Alan Turing's 1937 understanding of algorithm as mechanism, the media artist himself - while creatively reasoning - becomes machine. A conceptual artwork as well "may be constructed by anyone simply by following a set of written instructions" (ibid.). As it has been defined by Sol LeWitt, "[w]hen an artist uses a conceptual form of art, it means that all of the planning and

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[238] See W. E., Im Namen von Geschichte, Munich (Fink) 2003
[239] See Friedrich Kittler, There is No Software, in: Stanford Literary Review vol. 9, no. 1 (Spring 1992), 81-90
[240] https://en.wikipedia.org/wiki/Conceptual_art, accessed January 20, 2023

decisions are made beforehand and the execution is a perfunctory affair"[241]. What here still refers to conventional fine arts such as drawing and design, is already a function of the computational paradigm that reverses the traditional time-sequence of creating a piece of art first and to document it later. In media art, the electric circuit diagram, respectively the logical programming, actually precedes its technical embodiment respectively implementation - thereby enacting the very meaning of "technology" in the most literal sense. "The idea becomes a machine that makes the art" (LeWitt ibid.).

Closed Circuits

Video art protagonists Steina and Woody Vasulka frequently referred to their media-artistic and epistemological aesthetics as a dialogue with the tools and have focused on the autonomy - in fact, the techno*lógos* - they experienced with their artefacts in the production of "technical images" (to use a term coined by media philosopher Vilém Flusser). Their video works often display, list and credit the electronics they had used, including the tool builder's name[242], while at the same time granting video tools a creative subjectivity of its own.

With "closed circuit" installations that have been characteristic for early video art, the electronic circuitry itself has become the message of the cybernetic medium.

Fig.: Still from video installation Nam June Paik, TV Buddha (1974)[243]

While artistic performance has mostly been body-related in Fluxus art, it became replaced by an operative automatism.

The phenomenon-oriented artistic installation invites to be media-archaeologically contrasted with the circuit diagram of such a feedback loop as its technical and logical condition. Paik's work is described on the web site of the National Gallery Singapore under the heading "Medium": "Closed-circuit video installation with wooden sculpture, monitor and video camera. Video, single channel, 4:3 format, live feed dimensions variable"[244]

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[241] Sol LeWitt, Paragraphs on Conceptual Art, in: Artforum (June 1967), as quoted in Wikipedia, op. cit.
[242] As it is currently investigated in Jared Ashburn's forthcoming PhD thesis on *Tool Building in Video Arts Communities*
[243] https://explore.namjunepaik.sg/artwork-archival-highlights/tv-buddha
[244] https://explore.namjunepaik.sg/artwork-archival-highlights/tv-buddha, accessed January 30, 2023

In terms of art-critical *ekphrasis*, Paik's iconic installation "expresses the contrasts and parallels between East and West and between technology and spirituality in a very simple and direct way" (ibid.). In terms of second order cybernetics, though, the technical feedback is the message: "Here the Buddha is both the viewer and the viewed image, mirroring our own experience as mass media consumers" (ibid.). But not only in exhibitions, even in the Internet presentations the technical diagram of Paik's installation is not documented.

"Feedback occurs when outputs of a system are routed back as inputs as part of a chain of cause-and-effect that forms a circuit or loop. The system can then be said to feed back into itself."[245]

An outstanding feature of early media art, when the medium is still the message and thereby triggers truely media-archaeological aesthetics (or *aithesis*, close to the signal) - is the "white box" approach. They openly display the signal functions that reveal their nature as time-based technologies. Peter Weibel's tape loop installation "ICHMASSE" with its repeated "I"-articulation, as it has been reenacted by ZKM Karlsruhe in action, openly displays the technical configuration itself against the enigmatic acousmatic voice effect a mere loudspeaker installation would articulate:

Another seminal case is Alvin Lucier's magnetophone-based "operative" performance *I am Sitting in a Room* (1969), where the (both tape and cybernetic) "loops" of recording of his voice, its replay, and its re-recording, finally make the room itself articulate in its noisy patterns.[246]

A similar transparency of the technological ground (against the artistic figure) can be derived from Dan Graham's sketch (if not electronic block diagram) of his delayed-tape video installation *Present - Continuous - Past(s)*, 1974. Such *concept art* is known in the functional sense as well from visual editing software tools like Photoshop and Procreate. Here, the term is used for the "visual design for an item, character, or area that does not yet exist."[247] In media art, the conceptual diagram and its technical realization (circuitry) merge into one.

Fig.: Dan Graham, sketch of his delayed-tape video installation *Present - Continuous - Past(s)*, 1974[248]

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[245] https://en.wikipedia.org/wiki/Feedback, accessed January 30, 2023
[246] See Hanjo Berressem, Eigenvalue. Contemplating Media in Art [Sound / Image / Sense], New York / London (Bloomsbury Academic) 2018, Kapitel 1 "SOUND: 1969", 5-31
[247] https://en.wikipedia.org/wiki/Concept_art, Abruf 20. Februar 2023
[248] Web site Media Art Net, http://www.medienkunstnetz.de/works/present-continuous-pasts, accessed January 30. 2023

In Graham's video installation, mirrors reflect the present space, while a video camera tapes both what is immediately in front of it and the entire reflection on the opposite mirrored wall. "The image seen by the camera [...] appears eight seconds later in the video monitor (via a tape delay placed between the video recorder, which is recording, and a second video recorder, which is playing the recording back). [...] A person viewing the monitor sees both the image of himself or herself of eight seconds earlier, and what was reflected on the mirror from the monitor eight seconds prior to that – sixteen seconds in the past. [...] An infinite regress of time continuums" has thereby been created."[249]

The mechanism that is transparant in the technical sketch became a "black box" closure later, in favour of the more idealistic presentation of the artwork as interface appearance and subjective experience of time-shifted presence. Unless the technical diagram is co-presented (rather than: "documented"), the experience for the observer becomes metaphysical - against which media archaeology demands the revelation of its technical conditions in real-time.

[Plea for a re-monumentalization of technology-based artwork]

In museums, art centres, galleries, and other exhibition spaces, "increasing attention" is paid "to the documentary artistic heritage"[250]. Does this "archival turn" result in a new historicism concerning art presentation?

Somewhat close to Bernd and Hilla Becher's "cold" photographic gaze on industrial monuments, a re-monumentalization of the "document" is proposed. Media-archaeological analysis, instead of simply documenting works of art, transforms them *back* into their essential techno-logical monumentality. Instead of simply deciphering in media-artworks the traces left by men, "it now deploys a mass of elements that have to be grouped, made relevant, placed in relation to one another to form totalities". To paraphrase Foucault, there has been a time when art history, as a discipline devoted to silent objects without context, aspired to the documentary archive, providing meaning "through the restitution of a historical discourse; it might be said, to play on words a little, that in our time history aspires to the condition of archaeology, to the intrinsic description of the monument."[251]

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[249] Doug Hall / Sally Jo Fifer, Illuminating Video. An Essential Guide to Video Art, New York 1990, 186

[250] Conference proposal Anna Guasch

[251] Michel Foucault, Archaeology of Knowledge, transl. A. M. Sheridan Smith [*1972], London / New York (Routledge Classics) 2002, "Introduction", 3-19 (7 seq.)

An "intrinsic description" (Foucault) of a media artwork as "monument" in fact requires not human subject-oriented historiography, but a radically machine-oriented technical archaeography. This widens the scope of an exhibition space to the "alien phenomenology" (Bogost 2019) of the machine itself, as a co-present "observer" with its rather intrinsic electro-"proprioception".

Such an approach does not identify the human observer as the exclusive gravitational centre and primary inspiration of conceptual art work any more.

Case study: *We Found Our Own Reality*

Contemporary modes of presenting media art combine the exhibition of artistic productions - the artworks - and the materials that not simply accompany them as documents but actually constitute them as technical monuments. "A complex space opens up between creation and record" (Barcelona conference proposal), in which the focus is on the *frictions* which occur between the human artistic practice and the technical sphere of contemporary art. Where for conventional fine arts documentation is optional, for genuine media art this is mandatory, as it became evident in the central exhibition of the Berlin 2023 CTM Festival for Adventurous Music & Art[252], featuring a reconstruction of India's first electronic music studio, founded in 1969 at the National Institute of Design (NID) in Ahmedabad.[253] This exhibition did not simply put the experimental musical results on display, but took into account its machine agency as well.

Fig.: NID Electronic music studio[254]

The commemoration (or anamnesis) of this vintage studio took place in a combination of artistic (idiosyncratic) and documentary (archival) exhibition at Silent Green Kulturquartier (Berlin-Wedding): Paul Purgas' central audio-visual installation of *We Found Our Own Reality* on the one hand, with a documentary display of archival records (text, sound, images, artefacts) on the other. The exhibition addressed (media-)artistic creation in a media-archaeological, even: nonhuman way. Notably, the "Archive Area" encompassed material archival record(ing)s as well: not only vinyl discs, but as well original electro-acoustic hardware such as a

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[252] 27 January - 5 February 2023

[253] Forthcoming: Paul Purgas (ed.), Subcontinental Synthesis. Electronic Music at the National Institute of Design, India 1969-1972, London (Strange Attractor Press) July 2023

[254] From: https://www.tramway.org/event/056379cd-7862-44bf-ad2e-ad6b0082dcc6; January 28, 2023

MiniMoog electroacoustic synthesizer, reminding of the original modular Moog synthesizer in the NID studio. This has been a rigorous gesture against *dissimulatio artis* - the prevailing tendency to hide the technological condition (the Foucauldean *archive*) of contemporary media arts.

Significantly, Purgas' installation, in its previous Glasgow version[255], had been presented *without* the documentary "Archive Space" which was been added to the subsequent Berlin version. Thereby, the technical apparatus was not considered just supplementary any more, but became essential for the understanding of the actual media-artistic installation.

But still, a frozen archival or media-archaeological documentation does not suffice for media artworks, which - by definition - are radically *time-based* in their signal transduction and reiterative data processing. A processual documentation is required. "In artistic practice, many artists apply processual, projectual and archival methodologies, which [...] *even replaces the finalist and auratic character of the work of art*" itself (Barcelona conference proposal). Such an "archival" interest in documents traditionally used to be belated, after the actual presentation, but in the case of media artwork, the technical "archive" is in fact *en arché* part of such works. Different from the documentation of static fine arts work, it is mandatory to *re-enact* technical devices *in action*, just like a phonograpic "record" (to play with the terms here) only becomes media presence once it is processed on a turntable. This radically de-historicizes the "documentary" mode of contemporary art exhibitions.

For "digital" media art, the algorithm / diagram / score actually becomes identical with the art work itself. In Athens, an exhibition in memory of electro-acoustic composer Jannis Xenakis displayed his modular synthesizer together with its diagrammatic "score", that is, the signal generator in alliance with the symbolic notational order.

The "acousmatic" aesthetics of loudspeaker-sound replaying a composition of NID electronic music studio's archived tape recordings, in Purgas' Glasgow installation, dissimulated the sound production itself that has, in contrast, been revealed in the "Archive Room" of the Berlin exhibition version. But even in the "Archive Room", the MiniMoog Model D portable electronic synthesizer from the 1970s (an equivalent to the one brought to India by film composer Kersi Lord 1973) has been displayed in its outward design and interface (keyboard), *not* media-analytically opened for insight of its circuitry or cabling ("patch"), and

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[255] See the online video *We Found Our Own Reality*. Sound & vision installation by Paul Purgas, at Tramway, Glasgow, 2021, https://www.facebook.com/GlasgowTramway/videos/paul-purgas-we-found-our-own-reality/556483882099291

presented rather like a fossil museum artefact, than operatively re-enacted.

A truly media-artcritical insight can only be revealed by the techno-hardware documentation itself: Beyond the musical content which has been produced in the NID electronic studio and may be identified as local "Indian" tonalities (culture-specificity), the actual medium message (in McLuhan's sense) is the ubiquitous conquering of Western technology (electronics and later computing), with no decisively Indian medium specificity. Only from close media-archaeological analysis such "political" discourses on "transcultural dialogue" can start.

The *9 Evenings* as operative diagram

India's vintage electronic music studio in Ahmedabad had been substantially supported, even triggered, with electronic equipment and conceptual design by the US composer of electronic music David Tudor - who had been creating sound-generative, techno-enactive circuitry at the seminal *9 Evenings* event in New York 1966 (in analogy to the concept of "anactivism" in cognitive science where "cognition arises through a dynamic interaction between an acting organism and its environment"[256]). Tudor's patched "scores", as technical documentation, are no subsequent archival target, but have been a con-temporary condition of possibility (*arché*) and co-determination - even code-termination - for the artistic event to happen at all. For media art, documentation not only critically should be, but in fact *is* co-existent with its aesthetic presentation, such as - in another context - the diagrams for the circuits of Tudor's various electro-acoustic Rainforest installations.

Most media artworks confront the beholder with interfaces and leave him with an intransitive relation to its technical "subface"[257]. To open that black box and provide for a transient experience of the underlying technologies, the Berlin exhibition of Tudor's sound artworks *unexpecteed territories* in 2022 has not only been accompanied by lectures and performances but by workshops which enabled the audience to create (that is: solder and program) electro-acoustic devices on their own, to make effects such as "acoustic and electronic feedback as a compositional tool"[258] reenactable.

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[256] https://en.wikipedia.org/wiki/Enactivism, March 10, 2022, referring, int. al., to Francisco J Varela / Evan Thompson / Eleanor Rosch, The embodied mind: Cognitive science and human experience, Cambridge, Mass. / London (MIT Press) 1992

[257] See Frieder Nake, Das Doppelte Bild, in: Bildwelten des Wissens. Kunsthistorisches Jahrbuch für Bildkritik, vol. 3, no. 2 (2006), 40-50

[258] Workshop headed by Michael Johnsen

For media artworks to (literally) take place in space and "in time", the conventional exhibition space, or museum, is transformed into media theatre itself, including its technical documentation, such as it occurred in New York with the series of performances in 1966, under the name of *9 Evenings: Theatre and Engineering* where artists and engineers from Bell Laboratories collaborated in experiments between art and technology (E. A. T.).[259]

Especially with sound installations in media art, the "acousmatic" (Michel Chion) temptation of hiding the technical sound source behind its loudspeaker output prevails. This technology-specific situation is different from classical painting, where its "support" and materiality is more or less evident, as passive matter which has been informed by the artist.

The 9 Evenings program booklet cover itself openly displayed the circuit diagram of this techno-logical media theatre. The cover[260], designed by Pontus Hultén and distributed to the audience "shows a tangle of lines, a complex interweaving comprised of barely recognizable electronic symbols and scenographic notes. Like a palimpsest, the image consists of superimposed prints of each of the technical diagrams made for the event's ten performances"[261] which, when matched with other archival documents, allow us to identify their contents, more or less precisely." (Badiot, op. cit.)

"The very design of the program suggests the crucial significance of the diagrams. Yet it is still "unusual to present documents of this kind in a theater program" (Bardiot, ibid). - unless in true *media theatre*. "[S]pectators are more accustomed to seeing photographs, or even sketches relating to costuming or stage design. Produced by Bell Labs engineer Herb Schneider between the end of September and the beginning of October 1966, the diagrams 3 elucidate the important role of technology in the performances of 9 Evenings" (Bardiot ibid.).

The real challenge of the 9 Evenings performances was in "finding a common language that would allow the artists and engineers to communicate effectively. Ultimately the diagrams allowed them to establish that common ground [...]." (Bardiot, op. cit.) The operative diagram is therefore no external document, but inscribed to the art work(ing) from *within*, indissolubly interwoven. Documentation is realized

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[259] https://en.wikipedia.org/wiki/9_Evenings:_Theatre_and_Engineering, January 27, 2023

[260] Reproduced in: Clarisse Bardiot, The Diagrams of 9 evenings, translated from the French by Claire Grace, from: https://hal.science/hal-02338052/document, accessed January 30, 2023

[261] Bardiot, op. cit. The findings of her extensive analysis of each of these diagrams are presented on the Fondation Daniel Langlois (2005) website: http://www.fondationlanglois.org/flash/e/index.php?NumPage=571

here in a double sense of self-documentation, as it is evident in David Tudor's manipulations of electronic circuits: "His alterations were usually the result of a great deal of experimentation in which diagrams and sketches were used in the conceptual stage as well as for documenting his work"[262] - even extending to unrevealed evidence to the future, such as an unknown component that has been found (along with many others) at Tudor's home at Stony Point, NY. (ibid.):

Fig.: Tudor box.[263]

This means unearthing a different "documentary" archive. "These WERE unknown schematic diagrams."[264]

"[A]n analysis of the diagrams, combined with other visual documents (notably, the film footage shot by Alfons Schilling testimonials, and archival documents, allows us understand the architecture (which is to say, the entrances, exits, and the black box itself), the principal components, their distribution in space (between the central control panel, the stage, and the balconies) and the overall design of each performance." (Bardiot, op. cit.)

In the New York 9 Evenings case, "the relationship between the overall architecture and the placement of objects in the performance space allows us to determine whether the technical devices were visible on stage, or, on the other hand, were hidden from spectator's field of vision. Electing to show the technical apparatus, as do Cage, Tudor, and Alex Hay, and choosing to conceal it from view, as do Rauschenberg and Öyvind Fahlström, implies a markedly different aesthetic significance. The first approach reveals and deconstructs the mechanism, and reaffirms the link between objects and their effects, thus giving the spectator a certain critical perspective on the action taking place on stage. In the second approach, technology becomes something magical and mysterious, the effects of which the spectator experiences in an almost visceral sense" (Bardiot, op. cit.) - media-surgical indeed.

Instant documentation is mandatory for media art, in a tight, knotted grammatical conjunction of "artwork & documentation", to determine its degree of aesthetic dis/simulation, and to frankly reveal its techno*lógos* (even if this hurts the anthropocentric concept of the artwork.

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[262] Web site "Tudor's Electronics", https://davidtudor.org/Electronics/electronics.html, January 30, 2023
[263] From: web site "Tudor's Electronics", https://davidtudor.org/Electronics/electronics.html, January 30, 2023
[264] Unspecified comment on web site "Tudor's Electronics", https://davidtudor.org/Electronics/electronics.html, January 30, 2023

As long as the artists are individually involved in the production of the diagrams or codes "that are at once sketch and blueprint – one can discern the traces of the artists' personal understanding of the technology employed in their performances." (Bardiot, op. cit.)

Outlook: How to "document" AI-generated works of art?

But the documentary approach in media art exhibitions as co-presence of aesthetics with technical evidence, and the quest for immediate transparency of the technologies which condition such works of audio, visual, or computational art, reaches its limits with recent AI-generated imagery. The current debate about the explainability of Artificial Intelligence (XAI) addresses a core challenge: What is it exactly that should be documented, and made transparent, in artefacts which are generated by artificial neuronal nets from big cultural data training? Here, the "documentation" is receding, into the "deep" space of computational machine learning.

Traditional computer-generated visual artefacts have been *imaging* in the media-active sense of cybernetic "informational aesthetics" as declared by Max Bense, and put into practice by Frieder Nake on the basis of rather trivial program code. It is very unlikely that the logics of the output of a computer "will ever be more readable than its input"[265], Tony Hoare declared in 1973. Therefore, "[d]ocumentation must be regarded as an integral part of the process of design and coding" (ibid.) and both the technical diagram and the algorithm shall be presented with the media artwork in spatial and temporal co-presence.

The mechanism of artworks "created" by Generative Adversarial Neural Networks (such as StyleGAN) in AI, though, are more difficult to document in their pixel-to-pixel evolution, since they are rather probabilistic instanciations of image training sets and complex backpropagation on the basis of high-performance GPUs and advanced mathematical models like (hidden) Markov chains.

The traditional painter's signature, in the notorious AI-generated Portrait of Edmond de Belamy by artist cooperative Obvious, is disruptively replaced by a core algebraic formula of its generative algorithm.

This AI-generated art work is not even authorized by the name of its computer programmer. The line of its basic mathematic formula, instead, is not peripheral to the art(ificial intelligence) work, but a kind of self-

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[265] C. A. R. Hoare, Hints on Programming Language Design, Stanford Computer Science Report CS403 (October 1973), as quoted in Knuth 1984, xxx

documentation which is literally (or rather: algorithmically) inscribed *into* the artefact.

Listing the source code alone would not actually document the concrete genealogy of such an artwork any more, since such an "image" is rather the visualization of a probabilitic processes.

It "documents" the generative aesthetics of AI as an implicit work of tec-knowledge.

To make the implicit techno*lógos* explicit to humans "the output of algorithms needs to be transformed into a human understandable format. For this purpose different visualization techniques were proposed in the domain of computer vision."[266] Ironically, one way of still "understanding" the logic of AI-artistic production are *saliency (heat) maps* which mark the local centers of activity in artificial neuronal networks - a second-order kind of (non-artistic) "imaging".

Traditional authorship here dissolves into the *active archive* of code-in-action with the data it processes. There is no peripheral documentation of that artwork by accompanying documents any more as "traces and testimonies of the processes of creation, or elements that contextualise them" (conference proposal), but it is inscribed into the artwork itself. The "document" of the generative aesthetics of AI is an implicit work of tec-knowledge itself.

["Literate programming" (Knuth) and / as documentation]

This actually reminds of Donald E. Knuth's seminal plea for structured "literate programming" from 1984. While machines do not need any deeper "understanding" of its machine code in order to execute the algorithm, Knuth argues that for "explaining to human being what we want a computer to do" - actually XC, explainable computing -, "the time is ripe for significantly better documentation of programs [...] by considering programs to be *works of literature*"[267]. This step-wise understanding is not reduced to external "archival" documentation, but results in inscribing the documentation into the source code itself. Independent from any reference to so-called *conceptual art*, Knuth proposes "using a mixture of formal and informal methods that reinforce each other (ibid.).

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[266] Software for Explainable AI – Preface, in: Wojciech Samek / Grégoire Montavon / Andrea Vedaldi / Lars Kai Hansen / Klaus-Robert Müller (eds.), Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Cham (Springer Nature Switzerland) 2019, 396 seq.

[267] Donald E. Knuth, Literate Programming, in: The Computer Journal. British Computer Society, vol. 27, no. 2 (1984), 97–111 (97)

"A typical section begins with comments and ends with program text. The comments [...] explain noteworthy features of the program text."[268]

Knuth actually created a programming environment called WEB "that serves as the source language for two different system routines: one "produces a document that describes the program clearly and that facilitates program maintenance"[269] to human understanding. "The other line of processing [...] produces a machine-executable program. The program and its documentation are both generated from the same source."(Knuth ibid.)

For media art-specific "documentation", a special sophistication is required, both in engineering and in informatics: "[...] it's quite a pleasure to combine verbal and mathematical skills."[270]

[268] Knuth 1984: xxx
[269] Knuth 1984: xxx
[270] Knuth 1984, xxx