"RADICAL LOGO-TECHNICAL ANALYSIS: MEDIA SCIENCE, AND MEDIA ARCHAEOLOGY"

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Towards a Media Science:
(MIS-)UNDERSTANDING MEDIA WITH MCLUHAN

Message, massage: McLuhan's difference to Communication Studies

Although Marshall McLuhan is currently being re-discovered as a thinker of "social media" avant la lettre within the Internet community, the main lesson to take from McLuhan is still to look behind the computer screens, for a not content-orientated, but hidden message-orientated analysis. This requires - with and beyond McLuhan - a structural analysis of the techno-mathematical conditions of current media practices, to bring out the epistemological layers of such practices.

The message beyond McLuhan's grave is a critical awareness for media-induced phenomena acting upon humans in implicit ways. McLuhan has inspired neurological studies into mass media perception, that is: the awareness of subliminal processes induced by technical (mechanical and electronic) media such as later experimented by Herbert E. Krugmann's "Brain Wave Measures of Media Involvement"¹. McLuhan's seminal book Understanding Media originally did not result out of interest in media-epistemological theory right away, but originated more traditionally in communication studies. Understanding Media had been commissioned as an educational report to analyze the impact of watching television on school children. It was "absolutely McLuhan" to turn this study upside down, resulting in a most original analysis of the deep impact of media on human perception on the subliminal level. Understanding media is not about content, but the message and massage of the medium: the affective, neurological level, analogous to the figure/ground separation as developed in Gestalt psychology.

Expressing media theory: McLuhan the "man of letters"

McLuhan has been a man of the letter; as such, his legacy is an archive now. Once intellectual expression is coded into the symbolic regime of writing for transmission (publications) and storage (its libraries), it survives the author even post mortem. It is the marvellous quality of the archive as a time channel that it suspends writing from entropy. Is is still possible to derive fresh impulses from his thinking for contemporary media theory - as long as this reading is strictly analytic. McLuhan has been inspirative for generations of artists, but that does not turn him into an artist himself.

The message of McLuhan's publications, even if their aesthetic content is typographically experimental, is still the alphabetic regime which is symbols, not signals. In that world, an encounter with his writings is not simply historical but refreshing. In its very consequence this asks for a radically archival reading and archivographical writing of such intellectual heritage - which is today The Herbert Marshall McLuhan Fonds, held in the Library and Archives of Canada (LAC) in Ottawa, signature MG 31, D 156. As such, "McLuhan" has never become post-literate, but stays "M-C-L-U-H-A-N". His two bodies, the mortal and

¹ Published in: Journal of Advertising Research vol. 2, no 1 (February) 1971, 3-9
the intellectual one, have resulted in a grave and in an archive. Only in the
latter he has, in principle, become timeless, as long as is alphabetic letters can
be identified and copied without loss.

Showing McLuhan's audio and video recordings, results in a delusion, the realm
of signal recording where is no voice or face at all: McLuhan's second existence
in the electromagnetic sphere which he himself called "acoustic space".
Portraits of McLuhan nowadays are mostly images which have been digitally
refreshed (even regenerated) through algorithmic image processing. After
algorithmic analysis, what looks like McLuhan only superficially results in an
image for the sake of the phenomenal perspective of the human visual sense,
but in fact it is a computational object, a function of two-dimensional
coordinates (x, y) within a discrete matrix. Signal convolution (Faltung) in
digital image processing turns iconic content into information. Such a
convolutive turn is required for refreshing McLuhan.

**Refreshing McLuhan: "Media ecology"**

Cultural knowledge has resulted in technologies which develop into
autonomous systems. Marshall McLuhan has anticipated the current issues of
"media ecology" not in terms of environmental damage, but in its cybernetic
sense, with his diagnosis of the electric sphere becoming a second nature, a
"noosphere" (a neologism adopted from Teilhard de Chardin which links to the
current discourse on the "anthropocene" in the epistemological sense). In
McLuhan's media ecology, "the medium is the message" as well: "Any
understanding of social and cultural change is impossible without the
knowledge of the way media work as environments". McLuhan's focus, though,
is on "the phenomenology of media broadly defined through perception",13 while
the approach by radical media archaeology is distinct from such
anthropocentrism. Its focus is rather on the inverse ecology of technical media,
on micro-infracstructures, invironment. Media archaeology (in its "Berlin
school" version) carries McLuhan beyond McLuhan who once demanded that
"[t]he hidden aspects of the media are the things which should be taught" indeed, since "they have an irresistible force when invisible."4

But while being brilliant in the diagnosis of macro media infrastructures,
McLuhan failed in investigating its micro-infrastructure, the electronic circuitry
and its symbolic coding which now is the seven layers signal traffic as and in
the Internet. "When Sputnik went around the planet, nature disappeared [...] enclosed in a man-made environment."5 So far McLuhan's diagnosis. The

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2 Marshall McLuhan, the Medium is the Massage, New York / London (Penguin
Books) 1967, 26
3 Michael Durroch / Janine Marchessault, Media as Extension and Environment,
publication on occasion of the project Feedback #1: Marshall McLuhan and
the Arts, Den Haag (West) 2017
4 Marshall McLuhan in a post-lecture Q & A session recorded by ABC Radio
National Network on 27 June 1979 in Australia, from: youtu.be/a11DEFmoWcw?
t=4m30s (as quoted in Gottlieb 2017)
5 Marshall McLuhan, The Planet as Art Form. Interview with David Frost, The
American Broadcasting Corperation, 1972;
Sputnik choque in fact triggered the US-American counter-strategy of de-centralized communication structure resulting in the ARPA net indeed, prefiguring the Internet of today.

While the pervasiveness of electronic communication (from telephone over radio and finally television) has been McLuhan's contemporary concern, simply refreshing it for analysis of current media culture almost becomes a hindrance. McLuhan has not been that providential when it comes to the computational universe. Even if communicational media today are still wholeheartedly electronic, their essence has ontologically changed into the algorithmic, which is an objectification of the mind in a different way which McLuhan hardly addressed. At this point, we are asked to dis-continue his media theoretical heritage rather than simply to up-date it.

With his solid background in humanities, McLuhan has always remained a man of letters. He never really cared about the technical details of the electronic media he addressed as content of his analysis. The message of his experimental approach to typography of all kind (as displayed on exhibition here) is the Gutenberg galaxy. But typography has returned conceptually within the turingmachine itself and physically within silicon chips, and requires a different kind of artistic research: hard- and software-hacking.

McLuhan's impact (on occasion of the 50th anniversary of UM)

It is an indicator of discourse that the proper term "media" appeared in a non-technical book title at a time when the cultural impact of electronic media like radio and esp. television became evident - resulting in McLuhan's book Understanding Media. Is is only that escalation of electronic media (as opposed to printing and film before) that the notion of "media studies" found its proper discoursive place. Electronic media are signal-based, as opposed to cinematography with rather still relates to the mechanical age and the Gutenberg galaxy, as identified by McLuhan). From there results an additional, not humanities-centered media theory: Shannon's mathematical theory of communication.

By naming media in his book title Understanding Media in a sense not restricted to the term medium in physics (air, liquids, gases), McLuhan made clear that cultural engineering has escalated into electronic agencies whose impact on society and economy became so strong that it deserved an academic analysis of its own. McLuhan has created a non-content-oriented, non-hermeneutic "understanding" of media, focussing on their subliminal technologically induced messages. Mistaking "understanding" for sense-making itself would be a mis-understanding of media; therefore such analysis abolishes story-telling of media-(in-)"history". McLuhan's operative definition of media as signal events resonates with the media-archaeological approach today. Has

marshallmcluhanspeaks.com/interview/1972-the-planet-as-art-form, quoted after Gottlieb 2017

6 On the genealogy of terms like "communication" and Communication Studies see John Durham Peters, Speaking into the Air. A History of the Idea of Communicaiton, Chicago / London (Univ. of Chicago Pr.) 1999
McLuhan been a true media archaeologist *avant la lettre*? At one point, he compared his method with the one of archaeologists, but he never really took care in a close reading of the precise technological artefacts and their circuit diagrams. Media archaeology is "cold" in its non-hermeneutic gaze, but "hot" in focussing on technical details.

In consequence of McLuhan's initial remark that the real impact of any technology is the change of pace that it introduces into human affairs, the focus on media tempor(e)alities differs from the well-known "historical" ones. At that point, the reference to McLuhan's classic transcends it at the same time, across the historograpical border line which still limits *Understanding Media* - even if in his posthumous *Laws of Media* McLuhan experiments with a non-historical description of media time. McLuhan himself devoted chapter 15 to the impact of the mechanical, escapement-driven clock, linking it to typography and cinematograpic movement as opposed to the ephemeral fluidity of electricity. Electronic media which are the core of McLuhan's analysis are signal-based and incorporate a completely different chrono-poetics.

**Mis-Understanding Media: McLuhan's critique of Shannon**

McLuhan's insistence on the ground / figure difference can be interpreted as the difference between the media-archaeological layering of media against their phenomenological (mass) media appearance on the level of interfaces and other surfaces. This can be extended into the temporal domain, where frequency is the mathematical reversal of physical oscillations. High frequency carriers channels in tele-communication are being modulated by the varying low frequency articulations known to human perception as sound, music or speech, figuring or in-forming the basically *temporal* ground of transmission. Media archaeology is not only about spatial and topological grounds, but as well about the floating groundings: "Ground cannot be dealt with conceptually or abstractly: it is ceaselessly changing, dynamic, discontinous and heterogeneous, a mosaic of intervals and contours."

Applying this to audio media, especially to short wave AM radio, the apparant dichotomy between medium as content and as technologtical message turns out to be rather interlaced. When listening to a broadcast from Radio Kuwait in the early evening, the noise and the phase shifting are an articulation of the ionospheric channel of transmission (i. e. the "medium" in Shannon's sense) itself; the medium here is part of the message which, though, only becomes perceptible when being part of a successful reception of content.

McLuhan's focus on the message of the medium *as perceived by human senses*, though, lacks an essential understanding of the inner processes in telecommunication technologies for the second half of the 20th century and since, which is based upon the technomathematical theory of information as developed by Claude Shannon 1948 in his "Mathematical Theory of

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7 Interfaces, though, may be treated different from traditional surfaces, since they represent a technical coupling.

McLuhan's critical, almost satirical reading of the Shannon diagram as a simple linear sender/receiver-relation reveals his essential ignorance of the mathematical reasoning involved in digital communication engineering; this makes all the difference between an analysis of the impact of mass media on audiences on the one side, and media archaeology on the other.

McLuhan's critical comment on Shannon's communication diagram is a disastrous simplification of its mathematical understanding. In his 1978 essay "The Brain and the Media. The 'Western' Hemisphere", McLuhan attributes the Shannon-Weaver model of communication to the predominantly left-hemispheric Gutenberg galaxy.\textsuperscript{9} "The Shannon-Weaver model of communication [...] typifies left-brain lineal bias. It is a kind of pipeline model of a hardware container for software content. It [...] assumes that communication is a kind of literal matching rather than resonant making\textsuperscript{10} - which reveals McLuhan's kind of "analogue thinking" from the electronic media age (thus being closer to the analogue computer indeed). As has been expressed by a follower of McLuhan, the radio scholar Tony Schwartz: "Electronic media have been viewed merely as extensions of print, and therefore subject to the same grammar [...]. The patterned auditory and visual information on television or radio is not 'content'. Content is a print term [...] As stimuli, electronically mediated communication cannot be analyzed in the same way as print 'content'."\textsuperscript{11}

Can such an interpretation of electronic mass media still be applied to an analysis of the algorithms which rule digital communication media and scholarly research in times of Digital Humanities? McLuhan's brother in mind Schwartz continues: "The function of a communicator is to achieve a state of resonance with the person receiving visual and auditory stimuli from television, radio, records, etc. Decoding symbolic forms such as [...] written words is no longer our most significant problem. They extract meaning from perception in a manner prescribed by the structure of the language, code this meaning symbolically, and store it in the brain. But the brain does not store everything in this way. Many of our experiences with electronic media are recorded and stored in the same way that they are perceived. [...] since the experience is not stored in a symbolic form, it cannot be retrieved by symbolic cues."\textsuperscript{12}

But it is an almost Hegelean irony of technological reason in the history of cultural engineering, that what looks like non-symbolic (and rather signal-based) audiovisual media, in the epoch of digital communication re-turns in an even more rigid symbolic order. The implicit message of the meta-medium computer is that all former media (especially the signal-based ones) are

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\textsuperscript{10} Marshall McLuhan / Eric McLuhan 1988: 86
\textsuperscript{11} Tony Schwartz, The responsive chord, Garden City, New York (Anchor books) 1974, 19
\textsuperscript{12} Schwartz 1974: 24
symbolically transformed from distinct hardware to software, thus: software formats.\textsuperscript{13}

A first step in symbolic coding had been spoken language, then writing (especially the phonetic alphabet); these cultural technologies have since been more or less immediate to the human processor. Nowadays though, the alphanumeric programs remain hidden to most users.

\textbf{McLuhan's unease with media arts}

Both media theories and media arts develop in parallel (if not incommensurable) ways. A common method, though, which joins a certain kind of academic and artistic particed-based media research, is media archaeology\textsuperscript{14} which derives epistemogenic sparks (aesthetic or discursive knowledge) \textit{from within} technologies.

Marshall McLuhan has not only been highly influential on New Media Art, but once declared artists being the radar antennas to the changes induced by new technologies himself.\textsuperscript{15} Early 20th century artistic avant-gardes, like cubism, have been triggered by media technologies such as chronophotography indeed. But McLuhan's own experience in the recording studio for producing the experimental record \textit{The Medium is the Massage} apparently left him intellectually untouched.\textsuperscript{16} The philosopher of "acoustic space" as electrotechnical condition of media culture himself did not feel at home in the media arts. Even with Cera's triptych painting of a psychedelic TV at the front wall, art and science did not meet in the coach house of the Toronto University campus. McLuhan performed not as an artist, but as a true academic, with its predominant code of verbal and literary expression.

\textbf{MEDIA STUDIES. Communication and Beyond}

\textbf{Medium end(s)}

Media theoretical analysis starts with the very term \textit{medium} itself. By definition, Greek \textit{metaxy} (as defined by Aristotle in his \textit{Physics}, book IV) and its Latin translation \textit{medium} is the material channel of transmission, and

\begin{itemize}
  \item \textsuperscript{13}See Stefan Heidenreich, \textit{FlipFlop. Digitale Datenströme und die Kultur des 21. Jahrhunderts}, Munich / Vienna (Hanser) 2004
  \item \textsuperscript{15}See Baruch Gottlieb, \textit{Towards a Reasonable Ecology among the Media themselves}, Royal Academy of Art, The Hague, September 2017, Den Haag (West) 2017
  \item \textsuperscript{16}As remembered by his son Eric McLuhan, quoted by Michael Vazquez in the booklet accompanying the re-issue of the record, \textit{FDW7711-LP} (orig. 1968 Columbia LP CS 9501)
\end{itemize}
technically located inbetween sender and receiver, data input and output. The act of analog signal transmission is temporally ephemeral, almost "memoryless", while the data processing unit in computing already anticipates the output. In syllogistic reasoning, it is the "medium" term itself which has a functional existence, to vanish after the logical operation.

The familiar plurality of media itself has already started to converge into one dominant meta-medium, the interconnected computer. Books and newspapers, film, radio and television cease to exist as technically independent media; they rather return in a ghostly shape, as mere formats, within the computational frame in so-called "digital culture". Is the very term "media" itself doomed to be exhausted by universal computing?¹⁷

**German "media theory" avant la lettre**

In his *Grundlagen einer Philosophie der Technik* (1877), Ernst Kapp introduced the term "Organprojection" - a remarkable anticipation of McLuhan's prosthesis-theory of media when finally comparing telegraphy networks to the human nervous system itself. Sigmund Freud's notion of the Unconscious (the "psychischer Apparat") somewhat anticipates the French Apparatus approach (Baudry on the cinematic dispositif). Furthermore, Walter Benjamin sees human perception shaped by the variant historic media conditions. Close to what Marshall McLuhan later termed "the medium is the message" he interprets film not in its content but rather as a setting like a physiological experimental laboratory: "Das Publikum fühlt sich in den Darsteller nur ein, indem es sich in den Apparat einfühlt. Es übernimmt also dessen Haltung: es testet." The dramaturgy of "choque" accommodates the audience on the perceptual level to the speed of modernity and time-critical moments. This phenomenon has been investigated further by Paul Virilio's "dromology" which (like Heinrich Heine in his famous thesis of the annihilation of time by the new transport vehicle railway around 1840) swallows spatial distance in favour of the temporal trajectory (tele-presence).

This diagnosis has been shared by Martin Heidegger's notion of annihilation of distance ("Ent/fernung") by radio and television. Heidegger's philosophy of technology is an epistemological rather than engineering view ("Das Wesen des Technischen ist nichts Technisches"). Heidegger, after his post-war prohibition of teaching at university, still lingered as a ghost in the gang-ways of Freiburg university, inspiring a young generation of Friedrich Kittler, Norbert Bolz et al., while they were, at the same time, inspired by the neighbouring French (post-structuralists (Lacan, Foucault, Derrida).

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The Berlin model: *Kulturwissenschaft* and Media Studies in critical alliance

Parallel to the emergence of Media Science ("Medienwissenschaft", written in singular) as a proper academic discipline in German universities, "Kulturwissenschaft" arose as a field of research inspired by, among others, Aby Warburg. Especially with the re-organization of Humboldt University after the opening of the Berlin Wall in the beginning of the 1990s, "Kulturwissenschaft" as a discipline (written in the singular) developed a sharp methodological edge, orientated rather towards "Kulturtechniken" (cultural engineering) with projects like "Bild - Schrift - Zahl" and "Das technische Bild" (the technical image), both research projects at the interdisciplinary "Helmholtz Zentrum für Kulturtechnik".

Among the protagonists of "Kulturwissenschaft", Hartmut Böhme once defined the disciplinary matrix of "Kulturwissenschaft" in a way which claims to include (or absorbe) "Medienwissenschaft", arguing for a "interdisziplinäre Kulturwissenschaft mit offenen Augen für die Geschichte der technischen Welt". Wolfgang Frühwald rephrased this with a significant shift of emphasis (which has become the *credo* of the GfM in the meantime): a "kulturwissenschaftlich orientierte Medienwissenschaft". This perspective is critical. While cultural studies (including research on the technological impact) tend to reduce media to its discoursive effects rather than knowing media as technologies themselves (except a few scholars like Christian Kassung and others), media studies proper require a sound techno-mathematical and media-archaeological (-historical and -theoretical) knowledge and exercises how to develop epistemological questions out of that close knowledge.

The Different Meaning of "Communication" in Media Theory

Media archaeology rather relates to Claude Shannon's *Mathematical Theory of Communication* (1948) which does not confuse technical communication with mutual human understanding.

For conventional print and broadcast "mass" media studies, communication logocentrically referred to the distribution of the spoken word. In terms of what appears on interfaces, communication media, ranging from radio over television to second-order "radio" (smart phones), consist almost exclusively of human faces, voices and writing, addressed to other human eyes and ears. The actual media event, its signal engineering, is completely instrumentalized for anthropocentric semiotic exchange. But technical media are non interesting only as tools for intersubjective or collective human communication, but as agents of communication in themselves. Media archaeology is a temporary, epochal suspension from technological anthropocentrism, as a condition to epistemologically focus on the class of knowledge which implicitly results (partly non-intentionally) during the coming-into-being of such technologies.

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19 Böhme 1989: 30
20 Wolfgang Frühwald, Geisteswissenschaften heute. Eine Denkschrift, Frankfurt/M. (Suhrkamp) 1991, 156
Media Theory is characterized by its combination of close analysis of media technology with its deep philosophical reasoning. It rather stays close to the signal than to cultural and communicative semiotics. This peculiar mix of fascination with engineering together with epistemological reflection leads to a radical shift of focus of attention to communication not only between humans and machines but within machines themselves. 99 % of "media events" occur within technologies, unnoticed by humans in their interfacial use of "social" communication devices - more than ever in times of mobile media.

Norbert Wiener's 1942 typescript (classified as secret knowledge) has been a techno-mathematical analysis. Analog and digital communication, based on continuous signals or discrete symbols like telephone talks and telegraphic ("mobile media") messages can be mathematically correlated: "This is the study of messages, and their transmission, whether these messages be sequences of dots and dashes as in the Morse code or the teletypewriter, or sound-wave patterns as in the telephone or phonograph, or patterns representing visual images as in telephoto service and television. In all communication engineering [...] the message to be transmitted is represented as some sort of array of measurable quantities distributed in time. [...] by coding, or the use of the voice, or scanning, the message to be transmitted is developed into a time series."21

Shannon's *Mathematical Theory of Communication* (1948), as well as McLuhan's *Understanding Media* (1964), turned conventional communication studies upside down into emerging media studies proper by shifting attention from verbal, auditive or visual content to the techno-aesthetical message of media. The take-off of new German media theory, with Kittler's *Grammophon - Film - Typewriter* as an initial manifesto (1985), has been a radical technological grounding of French (post-)structuralism in the analysis of actual technologies, ranging from Lacan to "Foucault, the last historian or first archeologist". Such a grounding is by no means a simple extension of Lacan's psychoanalytical triple of the Real, the Symbolical, and the Imaginary to engineering, but actually reveals its different nature. While for machines, there is no "imaginary" at all, the "symbolic" becomes time-discrete signal processing (the numerical coding of the Real), and the somewhat undefinable psychic "real" is identified with mateReal noise. Instead of the psycho-logically unrepresentable, the mateReal and the tempoReal can be approached by techno-mathematical analysis (and subsequent synthesis) indeed. As remarked by the founder of the modern world-image (as analytic geometry) René Descartes, there is no soul in the machine, even if it mimicks the human - unless such performative simulation turn into operative, lógos-driven emulation. By-passing the human-centered approach, genuine techno-analysis starts from here.

21 Norbert Wiener, 1942, The Extrapolation, Interpolation und Smoothing of Stationary Time Series with Engineering Application, typeskript dated February 1st, 1942, 3, in: National Archives and Records Administration, Record Group 227 (Office of Scientific Research and Development), College Park, Maryland (USA), MFR, DIV.7-313.1-M2 (Division 7 Report to the Services No. 19. MIT Research Project No. DIC-6037; OSRD No. 370, Massachusetts Institute of Technology); print version 1949 (M.I.T. Press); 3rd ed. 1964
22 Kittler 1999: 5
Whereas communication studies are mostly concerned with the mass media transmission of cultural and political events, media archaeology poses the question of the "origin" of operative media on a deeper level, which is both the technical and the mathematical one - in the sense of the square root which is the symbolic expression of the verbal notion of arché.

The focus of media archaeology is on what unfolds within the technological channel which is usually bracketed by phenomenological, anthropocentric communication studies: "It was with good reason that Shannon's information theory [...] categorically distinguishes between the receiver and the recipient of the information, that is, the radio set and listeners - because he wanted to be able to leave the recipient out of the mathematical theory altogether." True media understanding gets epistemologically attuned to the technological between which has transsubstantiated from Aristotle's to metaxy as physical channel of communication (water, air) to technologically adopted electrophysicality, different from the media-phenomenological focus on interfaces as human media experience.

Such kind of media analysis (even media "science") emerged has rather diverse epistemological roots, like Ernst Kapp's Philosophie der Technik 1877, Fritz Heider's "Ding und Medium" (1926), Walter Benjamin's approach to "The Work of Art in the Age of its Technical Reproduction" (1936), and Martin Heidegger's "turn" in rethinking technique, while at the same time being heavily influenced by theories of computation and media engineering (Alan Turing 1937, Claude Shannon 1948), Jacques Lacan's equation of the human subconscious with the machine, and Michel Foucault's rigid discourse analysis.

New German media theory has emerged from the necessity to answer technological questions rarely posed by communication studies. The speculative nature of media epistemology rather links it to object-oriented ontology than to manifest content research, asking "What It's Like to Be a Thing?". Such an approach starts from a different concept of communication, understood not in the sociological but engineering sense, with "information" being a mathematical ratio (lógos) rather than a semiotic negotiation. The very term "communication" is the point of bifurcation between media science and communication studies. In communication engineering, "[t]he concept of information applies not to the individual messages (as the concept of meaning would), but rather to the situation as a whole". Mathematical calculation measures the temperature of communication, its entropy, that is: the amount of freedom of choice in selecting a message.

(Back-)Channels, and The Lógos of Technical Communication

Marshall McLuhan (1964) rather analysed the media technological message than its discursive "content" which he even dismissed as diverting critical

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24 Subtitle of Bogost 2012
25 Weaver 1949 / 1963: 9
attention. The historical economist Harold Innis focused on the bias of communication; its underlying orientation towards conquering either time (alias tradition) or space (alias telecommunication) is no metaphysical or social construction, but a function of its material or logistical techniques. But it is only with electronic media that communication transcends body-related cultural techniques to autonomous technologies.

Bertolt Brecht's "radio theory", around 1930, clearly underlined that it takes technical intervention to prevent the radio from becoming a passive consumer device. By activating the feedback channel, radio can be turned into a literal "communication device". Audio communication, as communication science, is focused on the physical and technical preconditions of communicative lógos.

By techno-logical necessity, Theodor W. Adorno's analysis of music in radio culture Current of Music, which stays close to the signal, once became incompatible with the rather sociological studies of the "Princeton Radio Research Project" directed by Lazarsfeld. The electromagnetic spectrum is made up of many kinds of waves most of which do not concern mass communication media. In "analog days", the limited of "radio" frequencies which can be squeezed in to a frequency band seemed to limit the expansion of communication media. So-called cognitive radio (time hopping, frequency hopping, once developed by Hedy Lamarr and George Antheil against interception of radio communication based on punched tapes known from music automata) has been the answer, as well as asynchronous transfer. Digitisation radically multiplied channels for transmission, which implies a radical transformation in the ontology of communication: its mathematisation and algorithmisation.

Paul Baran and Donald Watts, in 1963, developed packet switching as disentangled, in fact: literal de-construction of syntactically coherent communication; Bob Kahn's and Vinton Cerf's Transmission Control Protocol (TCP), later accompanied by Internet Protocol (IP), radicalize the postal epoque of address orientation; mighty compression and even predictive algorithms transform time-consuming into an almost immediate transmission. What looks like the return of face-to-face communication on the phenomenal surface for humans (technically true for time-continuous "live" transmission in analog electronic telecommunication), in fact is more non-linear (time-discretely temporalized) by nano-temporal calculation intervals than ever.

Especially with fiber optical cables for financial high frequency trading, networked locations can be addressed with the speed of electricity; digital immediacy replaces the still energetically biased notion of "mobile" transfer.

The essential message of the von Neumann architecture in current computing is algorithmic thinking and the stored program. To learn from the McLuhan method is to resist the temptation of submerging the analysis of current media culture to the media-sociological approach which looks at the figurative Medienwirkung (the social phenomena) first; media-archaeological analysis

instead identifies the deep impact of a current media system which McLuhan call it, according to the *Gestalt* approach in psychology, the "ground". The ground of electronic communication has been "acoustic space" (McLuhan) not in its manifeste, but epistemic sense. The classic "analog" model of mediated communication which has been channel-based transmission (tele-communication in the spatial sense, tradition in the temporal sense) is currently undertunneled by mathematically sophisticated data compression, calculating "real time" effects by means of statistical anticipation of immediately future events. The techno-logics of Internet communication replaces the cultural time-biased formation called "tradition" (in its fixation on the temporal channel) into a dynamic archive, with its primacy of techno-mathematical coding. Emphatic transmission (across spatial distance) by a channel is undone (or counter-matched) by pre-emptive mathematical calculation on the one hand, and re-placed by a thick net of micro-transmissions within processors.

Media archaeology tries to precisely locate the technological momentum where communication actually takes place: its material agencies. In the binary code of early electric computing, e. g., the thermionic tube (triode) functions in the discrete mode, different from linear amplification in telephone lines technology.

This different bridging of distances by binary quantities results in a new quality: "The network became machine. No longer was the network a passive device, for repeater amplifiers actively added energy along the route. This change decoupled the wave that represented the conversation from its physical embodiment in the cable. [...] Electricity in the wires was now merely a carrier, separate from the message or signals it carried [...]. Now voices becomes signals [...]. The message was no longer the medium; now it was a signal that could be understood and manipulated on its own terms, detached from its physical embodiment."27 Already Siemens' *regenerative repetitor* in electric telegraphy (the 19th century Indo-European Telegraph Line) did not amplify with signals as well the noise, but clearly differentiates binary *digits*.

"Digital" information replaces the energetically continuous time-signal in favour of time-discrete pulses. Thereby the US-American Bell System which started with telephony "became not merely a set of voice channels but a generalized system capable of carrying any signal as a new currency: information"28, transcending "communication" in the narrow human sense.

**The lógos of the Machine: Non-Human Communication**

Communication is about signal circulation in coupled systems, be it man-man, man-machine, or machine-machine(s). The use of the term "communication" in Claude Shannons "Mathematical Theory of Communication" from 194829,

28 Mindell 2004: 107
relieves the notion from all semantic aspects. In that sense, a transmitter of
radio waves "communicates" with the radio receiver, or computers
communicate with each other in the Internet. Not the quality of information
counts, but its quantitative measure, in the statistical sense. In information
engineering, the word communication includes all kinds of procedures by which
one human, or artificial, "mind" may affect another. This involves all kinds of
human behaviour, for which Weaver lists written and oral speech, also music,
the pictorial arts, the theatre, even the ballet. But "[i]n some connections it
may be desirable to use a still broader definition of communication, namely,
one which would include the procedures by means of which one mechanism
(say automatic equipment to track an airplane and compute its probable future
positions) affects another mechanism (say a guided missile chasing this
airplane)."\textsuperscript{30} Even without any human being involved, communication takes
place.

**Communication in Real-Time**

If communication is understood in the cybernetic sense, it is not restricted to
bridging space as telecommunication, but opens up a temporal horizon as well.
Predictive algorithms, once implemented in electronic computing machines,
allow for the anticipation of the future, in friendly or hostile communication
with an addressee: "The receiver's reaction can actually be observed (and thus
cause corrections with the sender) or it can be anticipated. For the latter case
of influence on the signal production by the sender's assumptions about
potential effects the term feedforward has also been suggested."\textsuperscript{31} Its media
archaeological primary scene has been the anti-aircraft prediction for ballistic
weapons in Second World War and the Anti-Missile program in the Cold War, as
developed in parallel lines by Norbert Wiener with Bigelow as applied time
series analysis, and by Claude Shannon.\textsuperscript{32} Shannon developed a model of
techno-mathematical enemy aircraft movement anticipation, where the human
factor (the pilot's intentional manoeuvres) is superseded and limited
(corrupted) by the mechanical behaviour of the airplane and other physical
parameters. In this model the real position of the enemy airplane at the
temporal moment $t$ is considered the "message", whereas registered deviations
represent "noise".\textsuperscript{33} Even miscommunication may turn out as productive from
the perspective of technical communication engineering.

**Between lógos and techné: Software Communication**

\textsuperscript{30} Warren Weaver, Introductory Note on the General Setting of the Analytical
Communication Studies, in: Claude Shannon / same author, The
Mathematical Theory of Communication [1949], Urbana (University of Illinois
Press) 1963, 3-28 (1)

\textsuperscript{31} Winfried Nöth, Handbook of Semiotics, Stuttgart 1990, 178

\textsuperscript{32} As described in Axel Roch, Claude E. Shannon. Spielzeug, Leben und die
geheime Geschichte seiner Theorie der Information, Berlin (gegenstalt Verlag)
2009

\textsuperscript{33} P. R. Masani, Norbert Wiener 1894-1964, Basel / Boston / Berlin (Birkhäuser)
1990, 186
Media archaeology as "critique" does not focus on cultural media content, but identifies the kind of knowledge which inherently unfolds from within hard- and software. Finding it impossible to separate between the cultural and the technical level in computing, media theorist Lev Manovich has created what he calls "cultural analytics", as a compromise between content-orientated mass media studies and hard core media archaeology. Critical software studies (Matthew Fuller et al.) look at the algorithms and their embeddedness in hardware structures themselves, while not neglecting its social and economic aspects.

Hardware- and code-focused knowledge of computing becomes "ubiquitous" with embedded computing, mobile media communication, and the operative temporality of the World Wide Web, like the time-critical "ping" signal, and its UNIX time concept. The debate about the US-American PRISM data surveillance system reminded of the necessity for "time-critical" media studies in both senses: in the sense of political analysis, and in the most precise sense of media archaeological hard- and software analysis. Obviously, PRISM roots in the fiber glass cables which link Continental European to British and US-American data transfer. "Big data traffic", as expression, has replaced "mass media communication". Such a cable can be "read" in terms of symbolical (binary) data processing.

The Insistence of "Humanities" in the "Digital"

To what degree do Media Studies still belong to the academic Humanities department? In the late Medieval kernel of what later became the academic university, the four "scientific arts", have been music, arithmetic, geometry and astronomy (the Quadrivium). Scientific lógos separated from human reasoning; the remaining three arts (the Trivium) constituted the "humanities" – grammar, logic, and rhetoric. In the Renaissance, the old Trivium became Studia humanitatis. With Digital Humanities, "science" and "humanities" fuse (or at least fold) into one, again. Humanist disciplines traditionally study subject matters to which the experimental method does not apply - "and instead mainly use the comparative method". With computational humanites, though, comparative research itself becomes algorithmically experimental.

"As humans and data machines become equal partners in cultural practice, social experience, and humanistic research, the humanities may no longer look like 'the humanities'." Digital post-Humanism is no more Geisteswissenschaft in Dilthey's sense. Still, Digital Humanities actually re-invents the informational aesthetics of cybernetics (Moles, Bense) - which is rather an up-dating than an exorcism of Geisteswissenschaft. In media theory there is a rather humanistic awareness (Geistesgegenwart) of algorithmic knowledge. It is not simply the quantitative increase of big data processing due to available computer storage and processing capacities (Moore's Law) which escalate in so-called digital culture, but its combination with a different quality of data processing:

35 Anne Burdick / Johanna Drucker / Peter Lunenfeld / Todd Presner / Jeffrey Schnapp, Digital_Humanities, Cambridge, MA (MIT Press) 2012, 105
algorithmic programming as techno-logical, rather mathematical "intellectualising" in the double technical and philosophical sense of computational intelligence.

Once the harvesting of "big data" turns into epistemogenic operations, quantities of digitised cultural sources become qualitative humanities. "DH" methods require both critical and epistemological reflection as has been traditionally cultivated within old-fashioned humanities. But when in the field of the human-machine interface, human-centered design aims at "usability" in the visual aesthetics of screen design, this is a rather weak version of "Humanities of the Digital", even a misconception. "Humanities of the digital"\textsuperscript{36} is not about re-humanising the digital world; on the contrary: "In order to reach true 'humanities of the digital', we - by a second-order observation – need to figure into our inquiries the human misconception of the digital itself and reduce it out of the equation"\textsuperscript{37}, rediscovering the rigour and the tools from what was once the humanities in order to "get to the core of the digital itself, its 'Being' in the Heideggerian sense, its procedures, its time-critical operations that leave what was once called the human behind" (idem). German Geisteswissenschaften are what roughly translates into "Humanities", but German "Geist", as lógos, gets another meaning when understood by technology: "It can also denote a ghost" (van Treeck). What culture perceives as human-minded agency (the Hegelean Geist) "could be just the ghosts of the machines, the technical media we use" (van Treeck). Humanities of the digital are not philosophical analysis of subjective consciousness, but techno-mathematical analytics turned into true sciences of the spirit. Computing machinery, instead of being non-human, is rather discovered within the human: "While other species have technology, only humans, so far, compute. Thus digital technologies [...], can be brought under humanist modes of study."\textsuperscript{38}

**Tracing Technológos**

Beyond the "question concerning technique" (Martin Heidegger), technology (closely deciphered in its composite sense) is more than simply a specification of what cultural engineering is in general: a negentropic, explicitly unnatural regime of symbolic manipulation impressed upon physical bodies and material (ranging from articulated language to traffic signs as "discourse" regulation). Once condensed in actual technologies, and understood as an "experimental epistemology" (Warren McCulloch), this encounter becomes a model of

\textsuperscript{36} As proposed, e. g., in the draft for the 13th International Conference on New Directions in the Humanities, 2015 special focus: From the Digital Humanities to a Humanities of the Digital, 17-19 June, 2015, University of British Columbia, Vancouver


experiencing the physical world itself, whose implicit eigenknowledge deserves to be uncovered and articulated explicitly by the media archaeológos.

The relation between mind and body or matter, and the embodiment of lógos in actual flesh, have concerned philosophy, and religion for centuries. The focus of Media Science, though, is on technológos. Its investigation is not the human performative, body-related, but the technological, therefore: operative aspect of this fundamental theme. The daring hypothesis is anthropic: The physical world needed human culture to become aware of its implicit knowledge by techno-experimental technology. Instead of inserting the question concerning technology into social history or history of science (Science and Technology Studies), media archaeology radically cuts short this horizon, and focuses on the disruptive new qualities arising from the tight coupling of matter and lógos in electro-physics and techno-mathematics. While cognitive neuroscience has developed the concept of the "embedded mind", operative reason (lógos), is understood as media in its strict techno-logical sense: as modulation and mastering of matter and energy by symbolically coded communication and control.

The question concerning technology deals with epistemic insights, which can be created from close, non-discursive technological analysis. With digital computing, media matter has radically become logified in the techno-mathematical sense. Since mathematical computation has resulted in actual computing, lógos has become a technical arché itself, as the implementation of symbolic reason into real matter. From there results a privileged affinity between mathematical (computational) reasoning and rigid media archaeological analysis. Precise technological analysis, in times of "cloud" and "embedded" computing, and within the discourses on the "Anthropocene", media ecology, "soft" (algorithmic) "thought" and "Deep" Learning, is at risk of being lost to speculative metaphysics. Radical Media Archaeology, on the contrary, insists on a critical rooting of such discourses in what actually happens within the techno-logical micro media theatre. Going medias in res, media archaeology aims at identifying, and archaeographically describing, the varying encounters of lógos and matter as the central event in media-technological culture, in exemplary, metonymic scenes, as first attempts towards a more comprehensive ontology of technológos.

Concerning technology, the varying media constellations between lógos and matter do not simply result in final relativism. Such encounters rather asks for a more radical, non-dichotomic, archaeological understanding of media as technology. Mind and matter, in the case of technological things, are not clearly separate entities a priori, but co-originary intertwined. While "analog" technologies represent primarily logified matter, digital machinery rather tends towards logo-technification, as "objectivization of the mind" (in Hegel's terms). Recent alternative approaches to computing allow for a material arché-lógos, unfolding a symbolical regime from within the physically real itself. While in the mathematical model of algorithmic procedures, reasoning has been logocentristically defined as (Turing) "machine", a different kind of machinery emerges where the relation between lógos and the matter it acts upon is no longer intransitive, but interacts with its materiality. "Machine learning", based on artificial neural nets, is still oriented at data. But what if lógos finally unfolds from operative matter itself?
TRANS- AND POST-URBAN COMMUNICATION

Telematic and / or urban space

Telephony from within buildings has long ago transcended the limits of intra-architectural communication, while not changing the architectural matter itself. Just ornamental, a telephone may have been carved into the facade like in the Cincinnati and Suburban Telephone Company Building (Harry Hake, 1931). 39

In both cases, in urban spaces and other territories, as well as in universal computing, architectures have sometimes been "rerouted" according to signal flows - even if what has affected theory and design, rarely evolved in practically new architectural territories. Architecture has been relocated by media technologies more conceptually than factually. "The representation of the contemporary city is [...] no longer determined by a ceremonial opening of gates, by a ritual of processions and parades, nor by a succession of streets and avenues. From now on, urban architecture must deal with the advent of a 'technological space-time'. The access protocol of telematics replaces that of the doorway. The revolving door is succeeded by 'data banks', by new rites of passage of a technical culture masked by the immateriality of its components: its networks, highway systems and diverse reticulations whose threads are no longer woven into the space of a constructed fabric but into the sequences of an imperceptible planning of time in which the interface man / machine replaces the façades of buildings and the surfaces of ground on which they stand." 40 But doors and gates return from within such technologies itself, as media infrastructures.

Not to be confused: Material transport and signal transmission

Different from the "deep history" of cities dating back to medieval times or even antiquity, most modern cities have a rather compressed genealogy of transformations in its infrastructures. More radically, this might rather be described as an archaeography of disruptions. Even the opening of borders and the subsequent passage of humans and vehicles through gates can be understood in more technological terms like signal transmission.

While in urban and social politics, migration remains a matter of moving real people, data migration is of a different kind - unless both actions are short circuited and the gap between bodily and data migration closes, with forensic voice recognition algorithms applied to localize and identify refugees at another country's border - from location to addressability. 41 Such automated

39 Reproduced in the "call for papers" to the Building Communication conference, Toronto, as cited
41 As presented in the talk by PhD candidate Michelle Pfeifer, Your Voice is (not) Your Passport: Voice Forensics and Asylum, at the conference
production of evidence is based on the spectrographic hard- and software tools which have previously been developed for scientific linguistic, phono-archival or ethno-musicological research.

To what degree do transport and passages of matter or bodies in urban space differ from coded or uncoded energy transmission? There is traffic passing through urban gates: moving bodies, bikes, automobiles. But there is a fundamental difference between physical transportation and the logistics of thermodynamic vehicles and material infrastructures such as streets, railway roads, architectural and urban gates, on the one hand, and transmission of signals according to the logics and protocols of data processing. Urban infrastructures might not be confused with the integrated circuitry of electronics (microchips) itself. Data compression by coding is even undoing delay of transfer with mathematical intelligence; here it is rather information which is passing through gates, while the mobile device travel with their users. "Protocols", rather than material hindrance, "are the immaterial groundwork of material infrastructures".

"Locative media" vs. "urban space"

The modern metropolis has become adapted and wholly absorbed into global mobile communication standards, losing its specificity; geophysical location (grounding) has been overshadowed (if not replaced, since real user bodies are still subject to physical being-there) by "locative media", which is: an address structure of global telecommunication systems like UMTS. Urban space has become a momentary point of receiving and sending data from myriads of individual mobile devices, be it tourists or native citizens. Location is not fixed to a unique place any more, but becomes mobile itself. "[A]dresses guarantee the correlation of devices and positions, while at the same time assuring that devices can move from one place to the other without losing connectivity." "The traditional division between the social and the technical becomes obsolete"; "social media" converge with the media-archaeological a priori which is the technology of triangulation, developed for this purpose since the 1950s at Bell Labs and Motorola. Movement of the device through the space of the network assures its localization. Always already being part of a communication network, the devices can be monitored. "The distance of a device is constantly measured in relation to at least three radio towers."
which means, beyond the imminent death of traditional analog radio, there is more "radio" than ever in communication media. Location-based services are offered by Google's Android and Apple's iOS, based upon the datasets of worldwide wifi networks. Thereby, the notion of "citizenship" is de-located.

On transmission as "bridging"

The conceptual difference, in media theory, between cultural techniques and technologies corresponds with the difference between material bridge constructions on the one hand, and transmission by electro-magnetic waves on the other. In Bertolt Brecht's *Lindberghflug*, as true media theatre in 1929, the airplane is an instanciation of material transportation, whereas radio wave transmission (the subject of Brecht's "Radio theory"[^47]) has been "bridging" the distance between Europe and North America at the speed of light. While the material bridge is stable, electro-magnetic bridging is vibrating itself in terms of high frequency resonance circuits, a repetitive temporal process. Material transportation implies delay in transmission (the actual transportation time), while immaterial radio transmission allows for "live" presence or the "mediated present" indeed.

Opening / Closing "Gates": Case Berlin

The opening of the Berlin wall on November 9, 1989, has been "historically" figurative. But the (back-)"ground", in McLuhan's terms, has been a deep media-epistemic transformation: the shift of emphasis from matter & energy (material "wall", physical hindrance) to "information", as it has been identified in Wiener's *Cybernetics* from 1948.

In the present media-cultural condition, a decisive difference endures between performative cultural techniques such as passages of bodies and vehicles through gates, and operative technologies such as signal flow between machines. "Code that runs on a machine is performative in a much stronger sense than that attributed to language. When language is said to be performative, the kinds of actions it 'performs' happen in the minds of humans, as when someone says 'I declare this legislative session open'" - or "open that wall", like US president Reagan during his Berlin visit in an address to Soviet Union president Gorbatchov. Even if such changes in minds might reach in behavioral effects, "the performative force of language is nonetheless tied to the external changes through complex chains of mediation. By contrast, code running in a digital computer causes changes in machine behaviour and, through networked ports and other interfaces, may initiate other changes, all implemented through transmission and execution of code."[^48] Only as a superficial phenomenon, the urban "Berlin experience" still escapes such codings.

While the opening of the Brandenburg Gate of Berlin in 1989 has become an anecdotic allegory of the end of the East / West Cold War divide, there had been a different opening and closing of logical gates operative within digital technology for decades.

In 1948, at the outbreak of the "cold war" between East and West - a period which ended with the opening of the Berlin wall in 1989 indeed⁴⁹ -, Norbert Wiener defined a transsubstantiation in communication engineering: "Information is information, not matter or energy. No materialism which does not admit this can survive at the present day."⁵⁰ Socialist countries collapsed since their economy, for ideological reasons, anachronistically insisted on the priority of matter and energy.⁵¹

The technological infrastructure had already transcended or rather undermined the political or ideological divide of the cold war military "blocks": The Soviet empire implicitly collapsed with its economic decision for computing hardware to become compatible to IBM software standards in early 1970s.⁵²

The Berlin wall has become a seductive but misleading metaphor for interrupted passage from the pre-information age. The new wall is the "firewall" for streaming data. The transition has not been that smooth as suggested in the notion of Transubstantiating Transmission: Walls become Ports become Channels⁵³, but rather a disruption, an originary bifurcation of two different regimes: the urban one and the micro-technological. Walls do not "become" ports but have been a precondition of binary computing (switching "gates") already.

Urban space is no "channel" of communication ("medium", in Shannon's terms), rather a sphere where channels in the more precise sense are being logically embedded and physically implemented. Sociological terminology might not be confused with the analysis of communication media condition; the "wall" metaphor might rather be addressed in cybernetic terms like "hindrance" (Shannon), logical "gates", and the binary "door" which allows for electric communication to flow exactly when it is closed (Lacan's definition of the

⁴⁹ For a transgressive reading of Berlin terrains and borders during Cold War in terms of electromagnetic radio spheres, see Alfredo Thiermann, Radio as Architecture: Notes toward the Redefinition of the Berlin Walls, in: gta papers 2 (2019) [ETH Zurich], 69-83
⁵¹ See W. E., Licht im Palast. Eine postmortale Erinnerung an den Code der DDR, in: Tumult (Vierteljahreszeitschrift), Nr. 1 (Frühjahr 2013), 54-56
⁵² A core thesis in Nitussov et al. (eds.) 2001
⁵³ Workshop title at NYU Berlin, October 12-13, 2018, organized by the Department of Media, Culture and Communication (MCC) at New York University and NYU-Berlin
"cybernetic door"\textsuperscript{54}, contrary to the intuition of opening or closing the passage by check points at the Berlin wall.

**ON THE NOTION OF CYBERNETIC FRICTIONS AND ITS ROLE IN THE DEPLOYMENT OF A RADICAL MEDIA ARCHAEOLOGY**

The co-organization of the lecture series *Applied Cybernetics: On the frictions concerning the mate(real)ization of cybernetic systems*, and its extended publication\textsuperscript{55}, by the Institute of Musicology and Media Studies at Humboldt University of Berlin and the Institute of Philosophy and History of Literature, Science and Technology at the Technical University of Berlin, has not simply been an administrative matter of academic cooperation, but is programmatic almost by necessity. It takes the combined effort of technical analysis (such as computer and engineering sciences) and the fields of the humanities (such as media epistemology, media archaeology, technopoietics, machine-oriented ontology) to address the temporal moments, and spatial sites, where cybernetics as a conceptual frame (the symbolic order) confronts its material "real" (its literal "materealization").

The core drama which is enacted on the scene of the technological world, are the entanglements of logical reason with the material real, or the mateReal (in the more Lacanean sense\textsuperscript{56}). Analog and digital media as technologies oscillate between logified matter and mechanized mind. "Radical" media archaeology is an adequate method of investigating concrete scenarios in, and as the cybernetic media theatre. The encounters of technical reason (\textit{lógos}) with informatizable matter occur in two ways: one being method, the other being actual realizations. Academic media science, with media archaeology as its method, radically "grounds" the investigation of technical things in actual matter and discovers its principal sources of action (archai). How close can such analytic \textit{lógos} get to what unfolds within the technical (mate-)real?

According to the radical media archaeology research hypothesis it is in the frictions, which occur in such confrontations, that the technológos of cybernetic thinking is revealed. The "frictionless" functioning of technology-b(i)ased communication, or a "friction-free world"\textsuperscript{57}, is an idealism, which does not pay account to the "veto" of its material implementation. Friction is a term well known from mechanical physics, but has been applied by Carl von Clausewitz' in his seminal theory of war (*Vom Kriege*, 1832) to describe the difference.

\textsuperscript{55} Both have been conceptually shaped, and organized, by doctorate candidate Diego Gómez-Venegas
\textsuperscript{56} For a media-scientific application of Jacques Lacan's psychoanalytic notions of "the symbolical" and "the real" to concrete technologies like the typewriter, and the phonograph, see Friedrich Kittler, Gramophone - Film - Typewriter, Stanford (University of Stanford Press) 1999
\textsuperscript{57} Don Tapscott / Alex Tapscott, Blockchain Revolution. How the Technology behind Bitcoin is changing Money, Business, and the World, New York, NY (Penguin Random House) 2016, 265
between the strategic diagram and the actual hindrances, which occur in its practical implementation: "Friktionen". In the case of the Cybersyn project in Chile, there have been two types of diagrams: the cybernetic design (Stafford Beer's "Viable System Model"), and the actually available technical system (the teletype net). But the range of processing the data incoming from state-owned factories across the country depended on the one and only IBM mainframe computer available in Santiago for the Cybersyn project.

This case might be generalized when it comes to explain some of the failures of projects, and applications, in the "heroic" era of cybernetic visions: its limited computational capacities, which were not yet ready for the implementation of "big data" processing in (almost) real-time - such as for the simulation, e. g., of neurological signal processing in the human brain, or what is called "deep" machine learning nowadays, even if the concept of Artificial Intelligence has been one of the core concepts developed in the classical cybernetic epoch. What nowadays is celebrated as Artificial Intelligence, Machine Learning, process simulations, and neuro-aesthetics, are to a large degree a re-occurrence of classic cybernetic reasoning, with the only difference that the computing processors these days can actually fulfil the cybernetic demands.

As an example, the former Institute for Cybernetics at Paderborn, directed by Helmar Frank, inaugurated the concept of "programmed instruction" for pedagogics in the 1960s ("programmierte Instruktion", in German) to implement in school classes not only automated learning, but to replace the teacher himself by an algorithm. Just at the moment when, in cooperation with the neighbouring Nixdorf computer company, Frank's institute had finally developed a model computer (MORE) as both learning aid and computer-didactic object of learning itself in the early 1970s, this TTL-based computational devices has been surpassed by the first generation of INTEL microchip-based home computers, which were more effective in terms of learning aids, but less conceptually prefigured in the cybernetic sense.

Another case is the seminal "Turtle", which has been constructed, among several versions, by neurologist William Grey Walter in 1951, as an operative demonstration of the core cybernetic thesis (Warren McCullochs "experimental epistemology") that already from a limited number of neurons in the brain, or its equivalent replacement by electro-magnetic relays, complex behaviour patterns emerge. Multiple frictions become evident in the difficulties when trying to derive, for a practical re-implementation, Walter's intention from his archivally preserved circuit diagram. In such an effort of a technical demonstration, the apparently "collateral" frictions become transparent only by

58 See Helmar Frank, Kybernetische Pädagogik, 2nd ed. xxx 1969, vol. II
59 See the lecture by Stefan Höltingen "Die Aktualisierung kybernetischen Lernens: Der Modellrechner des Instituts für Kybernetik im Signallabor der Medienwissenschaft", in the lecture series Applied Cybernetics from 13 November, 2019. The MORE computer is discussed in Helmar Frank / Ingeborg Meyer, Rechnerkunde, xxx 1970
60 See Friedrich Zuther, Die Aufhebung der Lehrautomatenentwicklung im Zuge der Entwicklung der Arbeitsplatzrechner, Aachen (Shaker) 1996
an actual re-enactment of Walter's mechanism. When such frictions are read with different, media-archaeological eyes, they rather point to the limits of a brain / computer analogy in a more epistemological sense.62

A decisive parameter of such frictions, which occur in the not simply logical, but as well technical implementation of cybernetic diagrams, is its actual temporal behaviour. "One important fact about the computing machine as well as the brain is that it operates in time"63 - that is, to be precise, "in different times". Already reformulating cognitive processes in technological terms, McCulloch insists: "thinking takes switching time" (ibid.). While the human brain "calculates" in the parallel mode, computing in the von Neumann architecture operate strictly sequentially. "[A]s long as we mean by 'parallel' only more simultaneous discrete operations, I do not think it is the basic problem."64 But it is in that "time of non-reality" (Norbert Wiener65) that the unconscious flashes up, as the tempoReal.

In 1948, at the outbreak of the "cold war" between East and West, Norbert Wiener defined a transubstantiation in communication engineering: "Information is information, not matter or energy. No materialism which does not admit this can survive at the present day."66 Socialist countries collapsed since their economy, for ideological reasons, anachronistically insisted on the priority of matter and energy.67 Still, applied cybernetics cannot be reduced to its logical, or mathematical, diagram, but it can operatively come into being only as techno-mathematics, or techno-logics, which makes all the friction-involving difference. That is why cybernetic systems cannot be reduced to purely semiotic, that is: symbolical analysis. The proof of cybernetic reasoning (the pudding) is in its material implementation (in its eating). The techno-practical computing being, as an instanciation of orders in the form of algorithmic programs, is the final criterium of truth for computational abstraction.68

62 As it has been realized (and presented in, and as, the Media Theatre) by Juliette Bal's Tortoise Juliette (with the engineering aid of Ingold Haedicke, Depart of Media Science, Humboldt University, Berlin
63 Wiener 1948/50: 214
67 See W. E., Licht im Palast. Eine postmortale Erinnerung an den Code der DDR, in: Tumult (Vierteljahreszeitschrift), Nr. 1 (Frühjahr 2013), 54-56
68 "Die Praxis ist in letzter Instanz das Wahrheitskriterium für mathematische Abstraktionen": Georg Klaus, Ein Beitrag zur Dialektik der Mathematik, in: Wissenschaftliche Zeitschrift der Friedrich-Schiller Universität Jena
"Many processes in nature must be such that we cannot understand them in terms of a computer program and at the same time put our understanding to the test by running the program on a machine."\(^{69}\)

Against the cybernetic idealism of a seamless modellability of human articulation by actual computing machines, J. C. R. Licklider's seminal text on the "Human-machine symbiosis"\(^{70}\) explicitly points to the differences, which arise in such the communication between a human and a non-human agency. Such frictions do not simply irritate the human-machine "dialogue", but actually reveal that the dialogic approach is wrong from the beginning. It is from the differences between human reasoning and technológos that a productive, informative interaction derives.

One of the variables which determine the frictions which occur when the symbolic order encounters the real is the human-machine coupling, and fully technological machine-machine coupling, as a central configuration of cybernetic systems. The media theoretical technológos hypothesis is that "the apparently always noisy attempts for bringing such cybernetic systems into full and successful application"\(^{71}\) is not accidental but indexical of the technological reasoning, which is at work behind its ideal design. This technological reality can be analytically delineated. A central thread of the *Applied Cybernetics* lecture series has been "to discuss if, considering the human-machine coupling as the core and hinge of any cybernetic system, the factors that may have truncated the historical deployment of cybernetics remain intrinsic to such core, are external to it, or respond to the articulating quality of such hinge" (Gómez-Venegas ibid.).

In the implementation of cybernetic reasoning, to what extent does the symbolic diagram (or code), and to what extend does technical matter matter? Concerning the Chile Cybersyn project, Fernando Flores in his letter (typescript) to Stafford Beer (Stafford Beer Archive, Liverpool John Morres University, Box 55), on 13 July 1971, pointed out the kairotic (time-critical) moment at which cybernetic thinking may become operative reality, and the opportunity to implement it on a national scale.\(^{72}\) Beer's first visit to Chile, in November 1971, resulted in flowcharts, notes and sketches. But against a metaphysical body / mind dichotomy (so familiar in occidental ontology), radical media archaeology insists that any symbolic operation is already "rooted" in activizable matter (be it the human brain, or electronics). To "en/code" already involves a material medium - in the sense of "implementation", which is a concept that always

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\(^{70}\) J. C. R. Licklider, Man-Computer Symbiosis, in: IRE Transactions on Human Factors in Electronics. HFE-1 (März 1960) No. 1, 4-10

\(^{71}\) Quoted from the initial draft by Diego Gómez-Venegas to the lecture series *Applied Cybernetics*

\(^{72}\) As it has been quoted in Gómez-Venegas lecture "Encoding from / to the real: On Cybersyn's symbolic politics of transmission" on 5 February 2020, within the *Applied Cybernetics* lecture series
already includes the options of its realization. It is only by its physical implementation that an abstract algorithm becomes actual software.

Institutionally, cybernetics has always oscillated between the rather goal-oriented engineering approach, and more abstract mathematical system modelling. This is the moment where the specific cultural and social contexts in which the application of particular case studies have been attempted need to be examined, since they privileged either of these approaches. While the tracing of the discursive, aesthetic, historical and / or political context, which are responsible for frictions that arose in the realizations of cybernetic systems, is the concern of Science and Technology Studies\(^\text{73}\), radical media archaeology analyses the (techno-)epistemological momentum in the actual mate(real)izations, which account for the scope, the success, and failures of cybernetics.

One critical aspect in the real implementation of the symbolic cybernetic order (feedback-enabled systems), which makes all the difference when turning the abstract diagram into an operative diagram (concretely: electric circuitry), is the tempoReal. This has been expressed in Beer's time-critical approach to economic (and other) operation management (in fact inherited from the previous "war theatre"). The "vast lag in the receipt of economic data" and the "bureaucratic time it takes to process these data"\(^\text{74}\), in cybernetic reasoning, required to be literally up-dated in favour of real-time data processing.

Another critical aspect of the encounters of the symbolic order with the mateReal is the difference between code (the algorithm) and electronic hardware, which is parallel to the difference between the abstract computation of the Turing machine, and actual computing. Operational diagrams require a material technological infrastructure, such as a telegraph network, in order to become dynamic cybernetic systems, which are endowed with negative feedback options in data teleprocessing, for the system to control itself, that is: to let its technológos articulate.

The architectural design for Ruhr University Bochum (RUB) in the West-German 1960s has been a pure product of cybernetic system thinking. The concept failed, to a large degree, in the moment of its sheer material implementation. Architecture cannot become cybernetic as long as its building materiality is not apt for recurrent modification by feedback. Only when a symbolic diagram is embedded in concrete matter, it becomes actual, operative circuitry. A rejected architectural proposal for the Ruhr University by Eckard Schulze-Fielitz, the Raumgitterstadt (space grid city), came close to architectural cybernetics.\(^\text{75}\)

"Based on adaptable tubular structures it would form a flexible architecture, that would enable the university to adapt to demand, climate and terrain [...] a true form of cybernetic architecture as it would have been able to react based on feedback."\(^\text{76}\) This echoes Negroponte's "architecture machine".\(^\text{77}\)

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74 Stafford Beer, Brain of the Firm, xxx, 248
In the planning of the Ruhr University architecture, its underlying diagram has been "the idea to prioritize informational flows" (van Treeck), thereby up-dating the concept of the German university by opening the doors between the previously strictly separated academic disciplines, as if they were logical gates in the computational engineering sense. But soon the friction between architectural lógos and architectural techné (its actual embodiment) occurred. Office services may be symbolically expressed in a process flowchart, and can thereby be formulated as an algorithm. But actual computing, such as in the so-called "von Neumann architecture", differs from macro-spatial building architecture indeed. Concrete architecture itself cannot incorporate the cybernetic techno-logics, since its crucial agency is missing. Feedback is the technoepistemic core of cybernetic (self)-governance, where output signals regulate the process by re-entry into the system "while running" (in real-time) as its information in positive (amplifying) or negative (self-regulating) ways. "Maybe architecture when it manifests itself in brick mortar and masses of concrete is not the right medium to incorporate feedback. At best it can facilitate it among the elements that make up the procedural flows it canalizes: people" (van Treeck 2019: 10).

After Second World War, beyond its manifest military applications such as the anti-aircraft prediction, cybernetic system theory has been extended to ecological questions, by conceptualizing the feedback loops between the environment and natural resources on the one hand, and its industrial appropriation on the other. The operators of such a modelling have been theoremes, mathematical analysis, and diagrams; its mathematical, and material computational episteme has been mainly been analog computing. Such diagrams became operative technical circuitry with H. T. Odum's application of "simple electrical networks composed of batteries, wires, resistors and capacitors as models for ecological systems" in the 1950s and 1960s. "These circuits were called passive analogs to differentiate them from operational analog computer circuits, which simulated systems in a different manner" (ibid.). Odum designed a symbolic language for the simulation, and modelling, of ecological, and social, systems with electronic units such as resistors for delay, or condensors for processes of short-term storage. "The language consists of a dozen basic modules, each having a mathematical definition." In the sense of an operative diagrammatics "the simulation

76 Jan Claas van Treeck, New Buildings for New Ideas? Ruhr-Universität Bochum and architectural Cybernetics, paper presented at the workshop Building Communication: Architectural History and Media Archaeology, University of Toronto, McLuhan Centre for Culture and Technology, February 8, 2019, Typoskript, 11
procedure for the energy circuit follows in simple automatic manner from the energy circuit diagram; the thinking on the behavior and structure of the system is done in the diagramming." Odum applied this cybernetic reasoning into a practical teaching program in the signal laboratory: "Students with a yen for the soldering iron can be utilized in combining physical and biological science to make a gadget, which mimics in some ways the flow of materials in the ecosystem." But anyone who has ever translated a circuit diagram into real circuitry has experienced the frictions which arise. Actual soldering is, in fact, the most concrete scene where the encounter of the symbolic order, or control, and matteReality takes place. A media theory of soldering is still missing. What comes close is the symbolic coding of a Field Programmable Gate Array (FPGA) in the computer microchip by means of the "Very High Speed Integrated Circuit Hardware Description Language" (VHSIC).

Odum's electrical models became early examples of a technically applied systems ecology, somewhat in parallel to Alban B. Phillips' hydraulic MONIAC (Monetary National Income Analogue Computer from 1949, as preserved in the London Science Museum) for the simulation of ecology. The technológos of such an approach, in the most media-archaeological sense, respects the material embodiment of any kind of symbolic thinking first: "Whereas operational analog methodology involves the writing of differential equations first, passive analog methodology bypasses the equations except to verify the similar behavior of the particular hardware pieces used. The energy network language and the electrical model are forms of mathematics in themselves, but forms that naturally resemble the normal ways of thinking in biology, ecology, and the social sciences." To sum up, the question arises: To what extend does a technical realization still relate to its cybernetic concept? The techno-logical frictions, which occurred, and still occur, in the efforts of mate(real)izing cybernetic systems, frequently resulting in their failure, are not simply collateral damage, or noisy disturbances of an otherwise intact reasonable concept. The material, and energetic, frictions that take place in the moment of "applied", that is: materially impelemented cybernetic system thought, have frequently been considered a troublesome side-effect. Against such idealistic (techno-)logocentrism, a different hypothesis has been proposed here: Such frictions are essentially inherent to the technológos of cybernetics itself. They deserve to be conceptually included in a techno-materialist second-order cybernetics. Concerning such frictions in the application of cybernetic projects, radical media archaeology (which differs here from cultural or discourse analysis) pays less attention to the specific cultural and social contexts which may explain such conflicts to occur, but to their necessity from within technologies themselves.

81 Odum 1972: 210
82 H. T., Odum, Ten classroom sessions in ecology. Am. Biol. Teacher 22 (1960), 71–78 (77)
83 See the brochure Löten lernen - Erfahrungssammlung aus der Praxis, (version January 2020) by Malte Schulze, student assistant and tutor at the Media Theatre of the Department of Media Science, Humboldt University, Berlin
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 media materialities which deserve to be remembered (in the cultural historical sense), or the be revealed (in the techno-logical sense). Its main divide is between the rather historical, or cultural, versus the technocentric approach.

Inspired by Michel Foucault's discourse analysis Archaeology of Knowledge, and his Order of Things. An Archaeology of the Human Sciences, and explicitly preceded by Ceram's Archaeology of Cinema, several scholars (Huhtamo, Zielinski) have applied the term "media archaeology" to the investigation of technical artefacts from the past which either pre-determine, still co-determine, or escaped the current narratives of media culture. Different from the concept of cultural techniques which are still body-related chains of technical operations, a more radical, technology-prone media archaeology grants the agency of the machine an autonomy of its own right.

In its "archaeological" (time-layered) rather than narrative (linear) approach, historical media archaeology is close to the history and epistemology of science (in the French tradition of Bachelard and Canguilhem), and Science and Technology Studies. Different from somewhat anthropocentric media phenomenology, media archaeology takes the non-discursive agencies of media culture into account, such as the arrangement of keys on a typewriter. Different from classical archaeology as academic discipline, technomathematical media archaeology not only encompasses material artefacts, but the analysis of their logical programming as well (media philology). The focus on hardware goes along with the "forensic" media analysis (Matthew Kirschenbaum, Morten Riis, Döring / Sonntag). Media archaeology refers to both a method and an object group of research. It cannot be reduced to a coherent school (Huhtamo / Parikka 2011), but different branches have developed in the meantime: the "Dead Media" approach (Bruce Sterling), historical media archaeology (Friedrich Kittler), cultural (tópos-oriented) media archaeology (Erkki Huhtamo), "prospective" media archaeology and "variantology" (Siegfried Zielinski). In a second generation, this has been extended to media-ecological issues concerned with electronic waste, energy consumption of

86 Michel Foucault, Archaeology of Knowledge and the Discourse on Language [FO 1969], transl. A. M. Sheridan-Smith, New York (Pantheon Books) 1972
digital media, and the "Anthropocene".\textsuperscript{89} Closer to the technological investigation stays computer archaeology (book series edited by Stefan Höltgen) and "radical" media archaeology and "archaeography"\textsuperscript{90}.

As a method of media analysis, media archaeology addresses the infrastructural level of media practice which Foucault named \textit{l'archive}: the governing laws of media, such as Internet protocols\textsuperscript{91}, or the von Neumann-architecture of digital computers. A more \textit{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 exercised 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 temporo(geal)ities: governing principles, archaic essentials - such as the \textit{enduring} infrastructure of the apparently dying mass medium radio, as radio wave-based infrastructure 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 \textit{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.\textsuperscript{92} 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 technológos, that is: the intertwining of the symbolical order (the code) with actual matter (the electro-technical implementation).

\textsuperscript{89} See Jussi Parikka, A Geology of Media, Minneapolis / London (University of Minnesota Press) 2015
\textsuperscript{90} See Hiller / Höltgen (eds.) 2019
\textsuperscript{92} 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 not 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."93 Admittedly, German pre-war engineering culture still lurks through, and the Heideggerian ways of fundamental rethinking of "technics".94 Today, one would add to the "the cold gaze" the unpassionate ears which listen to the implicitly "sonic", that is: wave- and rhythm-based temporal event emerging from, and within, technomathematical media.95

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 Heideggerian sense.96

There is a certain techno-logocentric, that is: machine- and code-centered school of media studies indeed.97 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. Media phenomenologists like Katherine Hayles,

94 Martin Heidegger, The question concerning technology and other essays, New York, NY (Garland) 1977
96 An argument in Geert Lovink, Der Verbleib der deutschen Medientheorie, in: idem, Zero comments. Elemente einer kritischen Internetkultur, Bielefeld (transcript) 2008, 129-145
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. 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"; 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 Bergsonian tradition, still insists on the coming-into-being of the mediated image in the "enframing" acts of the human bodily cognition only, 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 "Vorbewuβtes") in the micro-temporal field (Massumi). In the field of "posthuman cultural studies", 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 idiosyncrasies 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, the circuit design of a radio set is not a "text" any more but an operative diagram when set in media function. To what degree can textual and hermeneutic metaphors

99 Michel Foucault, The Archaeology of Knowledge, New York (Tavistock) 1972, 129 and 131
101 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)
102 Kirschenbaum 2008: 10 f.
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.¹⁰³ 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 field¹⁰⁴, there are different ways of practicing media archaeology. Many of them are "re-mediating" new media (theories) with previous ones recursively.¹⁰⁵ 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 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

¹⁰⁴ See Erkki Huhtamo's and Jussi Parikka's introductory chapter, An Archaeology of Media Archaeology, in: Huthamo / Parikka (eds.) 2011
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.106

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.107 "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.108 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.109

The Recurrence of Techno-Logical Configurations within Culture

Erkki Huhtamo's combination of tópos theory with media archaeology110 is inspired by Ernst Robert Curtius' studies of literary tradition in Europe111 where tópoi figure as formulas that traverse culture in persistent forms. What seems like unprecedented icons of media culture, such as human-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 photographs basis, or Vilém Flusser's concept of recurrent "gestures" in media culture. Such a

109 See Cornelius Borck, Electricity as a medium of psychic life.
111 Ernst Robert Curtius, Europäische Literatur und lateinisches Mittelalter, Bern / Munich 1948
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) themselves are identified as techno-logical topoi (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 (eigentime) unfolding in culture according to rhythms which differ from historical time. In the Renaissance, Nicola Vicentino proposed an "Archiorgan" 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 topos. 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.\textsuperscript{113}

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, 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 topoi 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).\textsuperscript{115}

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.\textsuperscript{116} 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

\textsuperscript{112} Sybille Krämer, Symbolische Maschinen. Die Idee der Formalisierung in geschichtlichem Abriß, Darmstadt 1988
\textsuperscript{113} Studio 31 (undated), The Musical World Beyond Twelve, in: projektstudio31, accessible online: www.projektstudio31.com (accessed 20 November 2019)
\textsuperscript{114} See Susan Blackmore, The Meme Machine, Oxford 1999
\textsuperscript{115} Friedrich Kittler, Aphrodite. Musik und Mathematik I, Teilband 1, München (Fink) 2006
laser discs. Such a computer initiative has been preceded by Oehler's project (with German computer industry Siemens) to automatize the metadata of photographs of ancient Roman sculptures (Monumenta Artis Romanae) at the Forschungsarchiv Römische Plastik (University of Cologne)\(^ {117}\). A more recent effort in that direction has been film maker Harun Farocki's project *Suchbilder*:\(^ {118}\)

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?\(^ {119}\) 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."\(^ {120}\) 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.

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.\(^ {121}\) 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

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The so-called "post-cinematic image" is different from the cuts and jumps and interactivity in computer games. How does the transmission (alias cultural "tradition") of technológos 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. 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. Whereby to most human 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, media archaeology separates the phenotype from the genotype of technology.

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124 See Jussi Parikka, Digital Contagions. A Media Archaeology of Computer Viruses, New York et al. (Peter Lang) 2007
125 "Nicht [...] eine ableitende Begründung, sondern [...] aufweisende Grund-Freilegung": Martin Heidegger, Sein und Zeit, 15th ed. Tübingen (Niemyer) 1979, 8
Media archaeology at first sight is about technological architectures, but it is concerned with media not only on their structural but also 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"\(^{127}\) 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"\(^{128}\).

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 "prehistory of media"? The term prehistory implies a certain teleology that is alien to technology.\(^{129}\) 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 catastrophe) 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\(^{130}\), 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

\(^{127}\) Denis Guedj, Numbers. The Universal Language, London (Thames & Hudson) 1998, 59
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.

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

While a specific branch of media-artistic research explicitly performs media-archaeological investigations of 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. 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(е)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 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". 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. 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 wavelength like in 1966. It is the power of the digital sampling theorem that it can emulate the analog 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" - 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.

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 epoch. In terms of McLuhan's media theory, preserving artistic content should reveal its underlying technological message which is its true "historical significance". 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.

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133 By the Archivio Home Movies / Art & Experimental Film, Bologna
134 Swade 1992: 208
137 "Als Medienträger sind für uns sowohl die Leinwand als auch die Medienapparate niemals zugänglich." Boris Groys, Unter Verdacht. Eine
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"\textsuperscript{138}, 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.\textsuperscript{139} 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, the exposure time has been codefining the iconic subject of the image - a temporal delay (\(\Delta t\)) which increasingly shrunked 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".\textsuperscript{140} 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 (\textit{techné}),

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Phänomenologie der Medien, Carl Hanser Verlag 2000, 21
138 See Inke Arns / Gabriele Horn (eds.), History will repeat itself. Strategies 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
140 From the Ars Electronica exhibition catalogue \textit{Eigenwelt der Apparatwelt}, ed. David Dunn, Linz 1992, 20
\end{flushright}
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 algorithms in digital works and the protocols of Internet art - belong to the functional, but not "ideal" aesthetic enunciation, and therefore are allowed to be replaced for re-enactment. The aesthetic content of media art asks 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-enactment 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 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 antinarrative in terms of meida discourse. The conditions under which media arts from the past can be said to have "presence' in the present" are strictly techno-logical.

**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*. The media-archaeographical description of an old Edison phonograph or an early home computer aims not at historicizing, but revealing "the deep physical and

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141 Julia Meuser, Copyright and the Integrity of the Work in Video Art, in: Kunstmuseum Wolfsburg (ed.), How durable is Video Art?, Wolfsburg 1997, 79
142 Sobchack 2011: 323
143 As accentuated by Sobchack 2011: 324
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 technological essentials and *principles* (the Latin equivalent to *arché*); 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 Baird144, 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 new kind of "intelligence" in discourse on "deep" machine learning, can be made explainable again by simply programming and implementing a neuronal network 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.145

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 be re-enacted in the present ("re-presenced")\textsuperscript{146}, 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 (\textit{kairotic} time), and virtually timeless code (\textit{aionic} time).\textsuperscript{147}

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 accessbility 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.\textsuperscript{148} Archaeography practices an alternative form of minimal, serial time-writing (or rather registering), closer to the programming of computers itself.\textsuperscript{149} Computers practically transform narrative aesthetics into non-discursive, algorithmic configuration of events. Current culture begins to acknowledge this different kind of chrono-\textit{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 technologies in time: their governing principles, their archaic essentials, their variabilities and invariances.

\begin{itemize}
\item \textsuperscript{146} 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
\item \textsuperscript{147} On \textit{kairotic} and \textit{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
\item \textsuperscript{148} See Friedrich Kittler, Draculas Vermächtnis. Technische Schriften, Leipzig 1993, 200
\item \textsuperscript{149} See Moritz Hiller / Stefan Höltgen (eds.), Archäographien. Aspekte einer Radikalen Medienarchäologie, Berlin (Schwabe) 2019
\end{itemize}
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."  

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."  

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 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

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150 Sobchack 2011: 329
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 Karsakov's 1832 design for an "intellectual machine". 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 techniques 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 "archeologists" of a different kind of knowledge themselves (understood here in Bruno Latour's sense of "non-human agencies).

While sharing with the classical archaeologist 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.

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 blame 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).
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 technological condition: "The archive is first the law of what can be said, the system that governs the appearance of statements as unique events."\(^{153}\) Archaeology in its traditional sense refers to the material 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.\(^{154}\) 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: discovering, 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 achieve the impression of a coherent image for (lagged) human perception at all.\(^{155}\)

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 archa*elogistics*.

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

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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 alphanumerical 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 single letter) transforms into a electro-physical signal. A transformation (or even "trans-substantiation" 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 prehistorical 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.

Media archaeology operates with a different tempor(e)ality 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. Inventors should be mentioned, but their creations are controlled by some rather external machinic logic. Media can be studied without people - 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

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156 As emphasiced in: http://www.agis.informatik.uni-bremen.de/ARCHIV/Publikationen/BegegnungenImZeichen.pdf
157 E-mail Cornelius Holtorf (Archaeology, Department of Cultural Sciences, Linnaeus University, Kalmar, Sweden; see http://web.comhem.se/cornelius), 7th January, 2015
behind the artistic or technical artefact, but rather with the techno-logical system embracing both, 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.

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 documents to be read, but monuments - 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. 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".

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163 See Tilman Baumgärtel, Schleifen. Geschichte und Ästhetik des Loops, demnächst Berlin (Kulturverlag Kadmos), 2015
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\textsuperscript{164}, up to the operative 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 \textit{(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 \textit{(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 explicitly 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 \textit{Apparatus} theory, notably Marcelin Pleynet, took account of the ideological \textit{a priori} (in the Kantean sense) of the technical apparatus: "[...] l'existence non significante d'un appareil producteur d'images, qu'on peut indifféremment 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\textsuperscript{165}, 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 typewriter 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.

\textbf{The Antiquarian Impulse in Media Archaeology}

\textsuperscript{164} Sybille Krämer, \textit{Symbolische Maschinen: die Idee der Formalisierung in geschichtlichem Abriß}. Darmstadt 1988, 88
\textsuperscript{165} "Éconimique, 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 and 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"\textsuperscript{166}, this is not meant as historicist musealization, but turns towards "prospective archaeology"\textsuperscript{167}.

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 Philosophers: As, Secrets and Experiments in Informatics, Geometry, Cosmography, Horologiography, Astronomy, Navigation, Musick, Opticks, Architecture, Statick, Mechanicks, Chymistry, Water-Work, Fire-Works, etc., Whereunto 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 reen acted (thus: deciphered, read, sonified). That is the 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\(^\text{168}\) 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 wanting 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 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.

\(^{168}\) Edition Two, Telharmonium Press, California, 2010
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" (deconstructing 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" - 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 not 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.

**Media Archaeology and / or Media Phenomenology**

Media archaeology and -archivology is a machine- and code-centered form of media studies indeed, rooted as much in Foucault's definitions 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

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169 In his book (Berlin 2012) *Jenseits der Medien* ("beyond media")
171 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
apparatus, that is, to the mind and senses. 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. 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". In order to grasp such non-perceptional sensibilities, radical media archaeology as a form of "posthuman cultural studies", rather takes the point of view (theoria) of the machine itself. Non-discursive media archaeology (recently rephrased as "variantology") is going "back to the roots" (Greek arché) in three ways: to the technical archive (in order to identify the time-critical momentum), 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

Media archaeological analysis (both academic and artistic) departs from the concrete "technical" (Simondon) 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

175 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)
176 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.
177 Siegfried Zielinski's book series on Variantology, starting with volume I (co-edited with Silvia M. Wagnermaier), Variantology. On Deep Time Relations of Arts, Sciences and Technologies, Cologne (Walther König), 2005
178 See Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009
179 Gilbert Simondon, Du Mode d'Existence des Objets Techniques, Paris (Aubier) 1958
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.”180), 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.181 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 view182, all kind of glitches and noise occur. In "post-digital" aesthetics 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"183. The strictly computational approach even celebrates incompleteness arisen from 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"184. 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"185.

180 Amsterdam et al. (Elsevier) 2016, 6 (italics W. E.)
181 See Mara Mills, On the Phone. Hearing Loss and Communication Engineering (forthcoming)
182 See Timothy Barker / Maria Korolkova (eds.), Misunderstanding, London (Bloomsbury), forthcoming
CLOSE TO THE SIGNAL. "Radical" Media Aisthesis

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 technológos of the media conditions insofar as this past (still) defines the present culture. Its temporal mode is not the past, but the present past, the Present - Continuous - Past(s) in terms of Dan Graham's notorious video installation from 1974, where the spectator, in the gallery, was confronted with his / her own image in an eight minute video tape time delay.

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 technológos) 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". But is this orientation, this insistence, and "rigorous attention to matter and machines," more than a "post-digital" nostalgia?

Even if the focus is "on intersections between media archaeology and artistic practice," 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 technológos (in Heideggerian 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 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 artificial 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 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".

[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 apriori, before Kittler's materialist turn transformed it upside down]

189 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
190 Mackenzie 2017: xi
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 technoepistemological insights which are derived immediately from within technology.]

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 conventional "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). 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. 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

191 Martin Kusch, Discursive formations and possible worlds. A reconstruction of Foucault's archeology, in: Science Studies 1 / 1989, 17-25 (17)
192 Friedrich A. Kittler, Die Maschinen und die Schuld, interview by Gerburg Treusch-Dieter in: Freitag No. 52/1, December 24, 1993
Radical media archaeology as research method and media-scientific approach relates to techno-epistemological reasoning and insights from 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)"\(^{193}\). On the other hand, the media archaeological 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\(^{194}\), 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 transubstantiation 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 the sparks of knowledge which can be the better derived, the closer the analysis stays with the technological event.

\(^{193}\) https://en.wikipedia.org/wiki/Science_and_technology_studies, accessed October 16, 2018

\(^{194}\) Ian Bogost, Alien Phenomenology, or What It's Like to Be a Thing, Minneapolis / London (Univ. of Minnesota Press) 2012, 25
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-phonics" 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". This logo-technical attitude has been prepared by the substitution 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.

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 alephemeneutic 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." If "media" is understood as technologies in 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...


196 Shari Wolk, An Undertaking: The Automation of a "girl-less, wait-less, and cuss-less" Telephone, talk presented at *Transubstantiating* conference, as cited.

\( lólogo s, \) 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.\(^{198}\)

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 Butler's science fiction novel \textit{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 epoch is closed again by becoming a mass medium for consumer communication.

Günther Anders' book \textit{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 \textit{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 knowledge is always already one step in advance of media-artistic anamnesis of such layers.\(^{199}\)

[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

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\(^{198}\) See Finn 2017: 23 f.

\(^{199}\) See Anthony Moore, Transactional Fluctuations 2. "Reflections on Sound", in: Siegfried Zielinski / Eckhard Früulus (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.)
Media-artistic archaeology detects, e. g., and re-sonifies, the presence of 13.56 MHz RFID tags used in plastic cards.200

**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.201 Critical media *aisthesis*, in consequence, stays close to the signal - either by its austere mathematical analysis (the "radical" archaeológos), 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"202, 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"203 - even if it remains unclear to what degree the sonosphere is an actual sonification of the material, and energetic, base of metaphorical "cloud" computing.204 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 AIS³, 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

201 See Karlheinz Barck / Peter Gente / Heidi Paris / Stefan Richter (eds.), *Aisthesis. Wahrnehmung heute oder Perspektiven einer anderen Ästhetik*, Leipzig (Reclam) 1990
203 [https://www.earthkeptwarm.com/the-cloud-is-more-than-air-and-water](https://www.earthkeptwarm.com/the-cloud-is-more-than-air-and-water)  (accessed 2 December 2019)
204 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
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? 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. 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 anaesthesia 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 tecnológos 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.

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 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. 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

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205 The symposium at the end of the installation had the title Physics & Art[efact], September 14 / 15, 2018
207 Boston, Mass. (M.I.T. Press), 2009
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.\(^\text{209}\) 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 the central trope of techno-rhetorics for media in order to be successful against human perception. Paranoia, in Boris Groys' sense\(^\text{210}\), 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.\(^\text{211}\)

At the same time, media archaeology, as a form of practice-based artistic research, is a genre of media aesthetics itself.\(^\text{212}\) 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

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\(^{210}\) Boris Groys, Unter Verdacht. Eine Phänomenologie der Medien, München (Hanser) 2000

\(^{211}\) See Jussi Parikka, What is Media Archaeology? , Cambridge / Malden, MA (Polity Press) 2012

performs a kind of acoustic media garbage archaeology by recollecting sonic articulations which became victim to lossy compression algorithms\(^{213}\),

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.\(^{214}\) 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 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"\(^{215}\). 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 eigenname, 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

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\(^{213}\)See [http://theghostinthemp3.com](http://theghostinthemp3.com); accessed January 4, 2016


\(^{215}\) Monika Wagner, *Das Material der Kunst. Eine andere Geschichte der Moderne*, Munich (Beck) 2001
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"\textsuperscript{216} and "platform studies"\textsuperscript{217}, and a refreshed materialist ("forensic") approach\textsuperscript{218}, look at the actual technological drama: the implementation of the symbolic order into the physical real as the core media archaeological scene.

**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.\textsuperscript{219}

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\textsuperscript{220}, the resulting project ("part archive, part nostalgia, part requiem"\textsuperscript{221}) 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."\textsuperscript{222}

\textsuperscript{217} Ian Bogost / Nick Montford, Racing the Beam. The Atari Video Computer System, Boston, Mass. (MIT Press), 2009
\textsuperscript{218} Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (MIT Press) 2008
\textsuperscript{219} 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
\textsuperscript{220} Bruce Sterling, The life and death of media, speech at Sixth International Symposium on Electronic Art ISEA ’95, Montreal, September 19, 1995
\textsuperscript{222} http://www.deadmedia.org/mailman/listinfo/deadmedia (accessed March 30, 2019)
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 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) 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 epoch 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 medium-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.

[Fig.: Spark-Gap-Raviv-Ganchrow-Kuenstlerhaus-Bethanien-15-Nov-2018.jpg]

Media-artistic research as method

224 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
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 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 utopian 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.

[Fig.: Jan-Peter R. Sonntag, ANATOMIE-Synthesizer-Sonntag-2.png]

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 logocentric 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" 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**

McLuhan, in the first chapter of *Understanding Media*, refers to Clement Greenberg's analysis that modernist painting itself has exhibited the grounding materiality of the rectangular canvas as its principal message. 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), 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.

![Fig.]

**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*, 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.

![Fig.]

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228 Johannes Gfeller, Anmerkungen zum restauratorischen Hintergrund der Ausstellung, in: Schubiger (ed.) 2009, 124-135 (125, figs. A and B)
Another example is the long-time ("Bergsonian") 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.

[Fig.]

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 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, transmitted, 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, 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. 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. In the technical sense, such disturbances actually disclose the physical nature of the transmission channel as core "medium" criterion, and is therefore part of technológos 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 but can become part of the media-artistic intention itself. The 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 unintentionally resulted from a laboratory signal event, while his media-artistic curiosity has been prepared to interpret such contingencies as "epistemic thing". 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.

230 In the gallery Parnaß, Wuppertal, from March 11th – 20th in 1963
233 According to http://experimentaltvcenter.org/video-terms
*Information* is that tape. Communication engineering defines information as a measure of uncertainty indeed (so-called Shannon entropy).  

**Sonic Media Archaeology**

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

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. Phonography did not just provide historical research with a new kind of source material; it rather articulates a new, almost ahistorical form of temporality 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" 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."

**Electronically Radicalising "Time-Based" Art**

Media analysis is basically the experimentation of temporal figures; the chronophotographical *dispositive* of Eadweard Muybridge was created to answer the question if horses in the course of galloping at one moment lift all four legs.

238 See Paul DeMarinis, Buried in Noise, ed. by Ingrid Beirer et al., Berlin (Kehrer) 2010
240 DeMarinis 2010: 247
241 DeMarinis 2010: 252
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 Invisible 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, making *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.

*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\(^242\), 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 "analogue" 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"\textsuperscript{243}.

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 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."\textsuperscript{244} Fry's *Deconstructulator* modified source code of the NES Cafe 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)


\textsuperscript{244} http://benfry.com/deconstructulator (last up-dated: November 2003; accessed April 21, 2016)
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 archaeology is not primarily about origins in the past, but about principles, the rules that govern media operativity both as hard- and as software commandment\(^{245}\): 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.\(^{246}\) Such temporalities are not necessarily of a historical kind - which is a 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 has 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."\(^{247}\)

**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

\(^{245}\)As defined in Jacques Derrida, Mal d'Archive, Paris 1995  
\(^{246}\)Jussi Parikka, A Geology of Media, Minneapolis / London (University of Minnesota Press) 2015  
\(^{247}\)Jussi Parikka, Cartographies of Media Archaeology, entry November 22, 2009, http://mediacartographies.blogspot.com
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, often used in the acoustic field to create new kinds of sound by means of a "jumper" cable which connects two points in the circuit in a way not intended by the engineers. Lev Thermen applied this already when applying radio technology to create his "Theremin vox" which invites for the active interference of the body as a capacitor (hand gestures) into an electromagnetically 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. 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.

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 technológos of works of media art. Artistic technologies here change from subjects to objects of media archaeology.

249 See the compilation CD Noise and Toys vol. 1 (2006)
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 underneath and the “formal materialism”, that is: the structure of its logical circuits and its data formats.251

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 simply for the documentation of algorithms, but for executable softare, are required.

**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 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.252

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 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.253 If the

252 http://www.youtube.com/watch?v=JHC1CdgfkVo  
253 Ray Edmondson, AV archiving philosophy - the technical dimension, in: Proceedings of the IAMI-IASA Joint Anjual Conference, Perugia 1996, no. 8
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 [...]."\textsuperscript{254} 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"\textsuperscript{255} by means of algorithmic signal detection and filtering software. An ironic echo is the \textit{VinylVideo} project, which Gerhard Sengmüller calls a "piece of faked media archaeology"\textsuperscript{256}.

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 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

254 National Archives (Canada), H. M. McLuhan Papers, H. M. McLuhan to Jerry Agel, 26 March 1976
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. Kirschenbaum analytically separates forensic (hardware) and formal (software) materiality while admitting its increasing interlacing. An EEPROM, for example, is an electrically 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 unique quality of being here and now, 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

258 Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008 111
259 As defined in Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit [*1936], Frankfurt / M. (Suhrkamp) 1969, 14
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 diminishes 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 irreversible 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 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.260

The media archaeological approach to the preservation of (digital) media art focuses on the conditions of possibility 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.261

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 or after digitizing a tape."262

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."263 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.264 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

262 http://mattersinmediaart.org/sustaining-your-collection.html
same medium [...] it follows that a UTM could emulate itself.” 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 the temporal dimension functional emulation (the matalhistorical 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 fornting 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.\textsuperscript{266} Computational art exists in "turing time" (Friedrich Kittler) which fundamentally differs from the historicist temporal order which has concerned media (art) preservation so far.

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 preservation but deserve unfolding their epistemic delicacy in terms of object-oriented ontology.

\textbf{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,

\textsuperscript{266} 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
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\(^{267}\), 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 obsolecence 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\(^{268}\), and b) in terms of its techno-logical infrastructure. 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")\(^{269}\) is no mere figure in the philosopy 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


\(^{268}\) 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

\(^{269}\) 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
which entropically attacked other matter, and ends in private and public museum collections. The conference focuses on the obsolescence of Internet and Web based artworks - with some of them actually reflecting upon their own ephemerality, such as the seminal JODY website.270

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 technológos, since the transmission itself was literally to log in. "They succeeded in transmitting the 'I' and the 'o' and the the system crashed!"271 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.272 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 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. 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" 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." 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 millennia, 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 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? 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

273 See Harold Innis, The Bias of Communication, Toronto (University of Toronto Press) 1982
275 Godfrey 1986: 171
(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, administrative 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*277, 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".278 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 already279 - including the necessity of a repository like GitHub for preserving the source code behind all the software which is involved.280 But the anticipation of "The Dead Web" goes beyond. In the Molior exhibition project281, 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

278 See W. E., Historismus im Verzug. Museale Antike(n)rezeption im britischen Neoklassizismus (und jenseits), Hagen (Margit Rottmann Medienverlag) 1992
279 See, e. g., the workshop *Kultur-Back-Up* at Hochschule Mainz, Germany, October 29 / 30, 2019, http://vangogh.tv.hs-mainz.de/?page_id=589
281 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
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"\textsuperscript{282} 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"\textsuperscript{283} - like from silicon, which is literally the material basis of the Internet.


\textsuperscript{283} Michel Foucault, The Order of Things. An Archaeology of the Human Sciences [FO 1966], Oxford / New York (Routledge) 1989, 422